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1939

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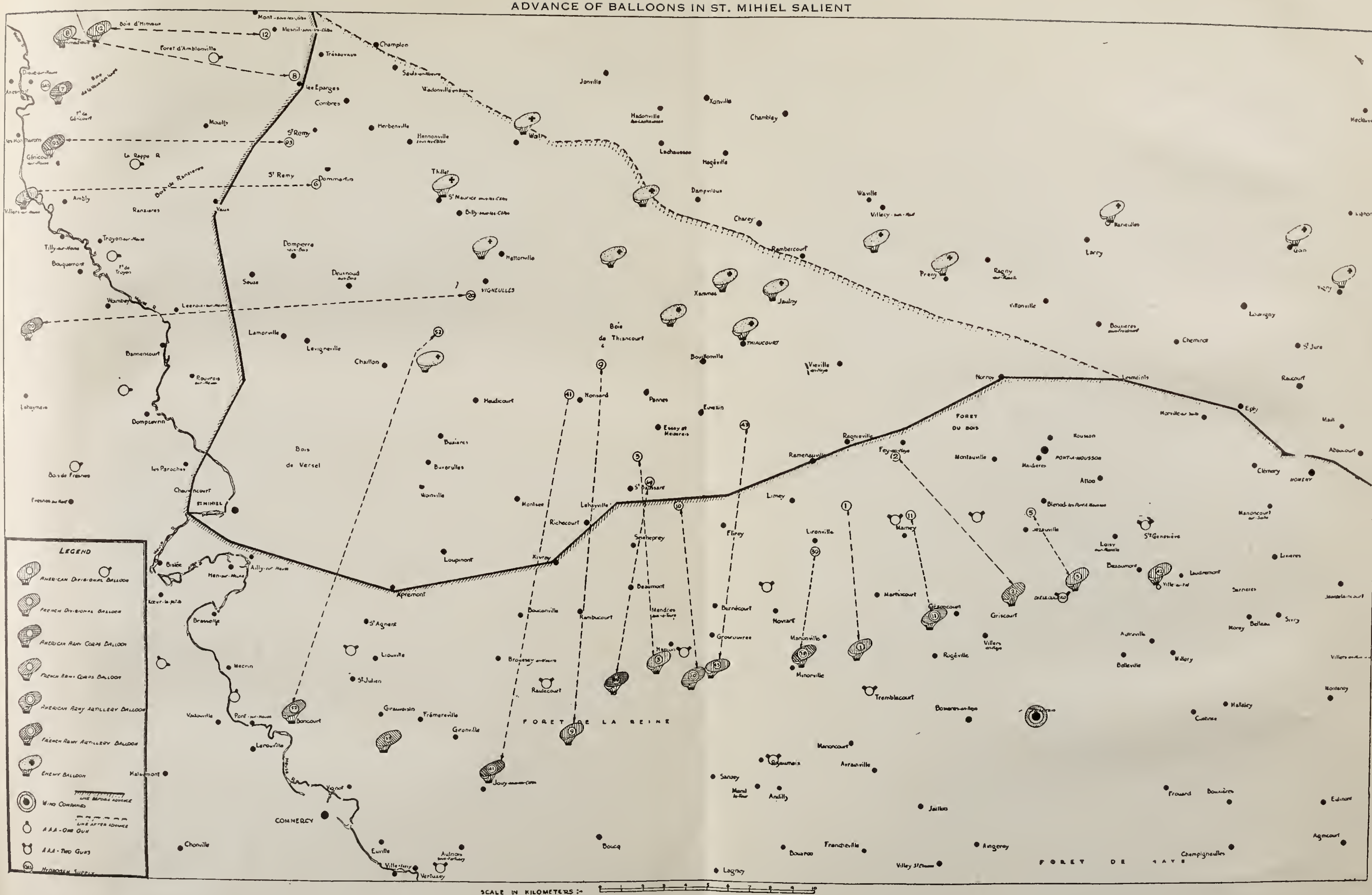
ADVANCE OF BALLOONS IN ST. MIHIEL SALIENT



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OF THE SCHOOL OF INSTRUCTION
ARMY BALLOON SCHOOL
ARCADIA, CALIF.

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Edited by H. E. Weeks, Second Lieut., A.S., A.

A Medium for Collecting and Imparting Information in Regard to Balloon Observation

NOTICE.

Commissioned Officers of the Army Balloon School at Arcadia may obtain copies of the Weekly Bulletin after 1 o'clock on the Thursday of each week by applying in person to Lieut Weeks' office in the Instruction Building. Copies of each week's issue will be available until the supply is exhausted.

INDEX.

BALLOON OPERATIONS IN THE ST. MIHIEL SECTOR

I

ORGANIZATION

(A) Assignment and Distribution.

Twenty-one Allied balloons took part in the offensive in the Saint Mihiel Sector, from September 12 to September 16, 1918. Fifteen of these balloons were American; six were French.

The assignment and geographical distribution of these balloons, at the beginning of the offensive were as follows:

Company	Assignment	Location
2nd Balloon Co.	1st Army Corps (Corps Artillery)	Griscourt
1st Balloon Co.	1st Army Corps	Domevre-en-Haye
5th Balloon Co.	1st Army Corps	Dieulouard
42nd Balloon Co.	1st Army Corps	Volle-au-Val
3rd Balloon Co.	4th Army Corps	Hamonville
9th Balloon Co.	4th Army Corps	Raulecourt
43rd Balloon Co.	4th Army Corps	Ansauville
69th Balloon Co.	4th Army Corps (Corps Artillery	Neuf Etang-de-Mandres
7th Balloon Co.	5th Army Corps (Corps Artillery)	Fort Genicourt
6th Balloon Co.	5th Army Corps	Villers-sur-Meuse
8th Balloon Co.	5th Army Corps	Dieue-sur-Meuse
12th Balloon Co.	5th Army Corps	Sommedieue
52nd Balloon Co.	(French) 2nd Colonial Corps	Boncourt
53rd Balloon Co.	(French) 2nd Colonial Corps	Vignot (in reserve)
20th Balloon Co.	(French) 2d Coloniel Corps	Thillombois
10th Balloon Co.	Army Artillery	Ansauville
11th Balloon Co.	Army Artillery	Gezencourt
16th Balloon Co.	Army Artillery	Toul (in reserve)
39th Balloon Co.	(French) Army Art.	Minorville
41st Balloon Co.	(French) Army Art.	Gironville
93rd Balloon Co.	(French) Army Art.	Genicourt

(B) The Advance.

The approximate positions of these balloons, at the end of the offensive, were as follows:

Company	Location
2nd Balloon Co.	Fay-en-Haye
1st Balloon Co.	Bois-de-la-Haut
5th Balloon Co.	Jezainville
42nd Balloon Co.	Vile-au-Val
3rd Balloon Co.	Maizerais
9th Balloon Co.	Lamarche
43rd Balloon Co.	Bois-de-Euvezin
69th Balloon Co.	St. Baussant
7th Balloon Co.	Sommedieue
6th Balloon Co.	Dommortin
8th Balloon Co.	Les Eparges
12th Balloon Co.—(French)	Mesnil-sous-les-Cotes

52nd Balloon Co.—(French)	Creue
53rd Balloon Co.—(French)	Vignot (in reserve)
20th Balloon Co.	Vigneulles
10th Balloon Co.	Bois-de-la-Somnard
11th Balloon Co.	Mamey
16th Balloon Co.	Toul (in reserve)
39th Balloon Co.—(French)	Lironville
41st Balloon Co.—(French)	Nonsard
93rd Balloon Co.—(French)	St. Remy

The study of the map reveals that the Allied balloons, in this offensive, made an aggregate advance of 202 kilometres. This estimate is figured by direct line from original position. The number of actual road miles greatly exceeds the figure indicated.

(C) Preliminary Reconnaissance.

The positions of advance and retreat were thoroughly reconnoitered before the attack began, insofar as proximity to the front permitted. Thirty-five positions—alternative, advance and retreat—were actually inspected on the ground. The territory beyond the front line was carefully studied by means of maps and photographs. Definite itineraries of advance were planned and the positions beyond the lines so determined that each balloon maintained, approximately, its place in the axis of its sector.

(D) Supply.

Hydrogen was distributed to the companies from the gas depot at Chaudeney and Rattentout. Arrangements had been made with the Commandant d' Aerostation of the VIII. ieme Armee for an original supply of 1,500 tubes at Chaudeney and for a daily provision thereafter of 100 tubes per day.

Spare balloons, baskets, parachutes and accessories were available at the 1st Air Depot. No shortage in equipment was encountered.

(E) Communication.

Telephone connections were established between Headquarters Commander Army Balloons and each Corps Balloon office; between each Corps Balloon office and each balloon assigned to the Corps; between balloons and Artillery Groups and Groupments; between balloons and Corps or Divisional Intelligence offices.

Indicatives and wave-lengths were assigned by the Army Radio Officer so that each balloon could keep in touch by wireless with the Artillery Squadrons and with Artillery Groups and Groupments.

(F) Administration.

All air service units—American and French—were under the tactical direction of the Chief Air Service, First Army. The French companies were attached for administrative control to the 8th French Army, 2nd French Army or 2nd Colonial Corps, depending upon the sector in which the company was operating.

II
MISSIONS

(A) Intelligence.

(1) Surveillance.

The weather during the first two days of the attack was rainy and stormy. Visibility was poor and strong wind made ascension perilous. The balloons, however, in practically every instance, were up at daybreak on the morning of the attack. One balloon in each Corps was in ascension during the night preceding the attack and during each night while the attack continued. Surveillance was constantly maintained; movements of the troops were watched; fires and explosions were noted; enemy aeronautical and artillery activity were observed.

The American balloons, on September 16th, reported enemy shells falling 116 times; reported enemy balloons 50 times; reported enemy planes 119 times; reported circulation on roads 23 times; and spotted 35 enemy batteries. The total hours of ascension of American balloons on this date were 142 hours, 33 minutes.

(2) Reports.

Reports were rendered by all balloons at frequent intervals. Written operation reports were submitted daily to the Corps Balloon office by balloons assigned to Corps and to the Army Balloon office by balloons assigned to Army Artillery. Telephonic reports were renderd by balloons assigned to Corps, at indeterminate intervals, to G-2 at Divisional and Army Corps Headquarters. Telephonic reports were made by Army Artillery balloons to Army Artillery Headquarters, to the A. I. S. and to G-2 of the Corps in the sector in which the Army balloon was functioning. The Adjutant at each Corps Balloon office submitted a consolidated report daily to G-2 and G-3 of the Corps, and to the Commander Army Balloons. The Adjutant at each Corps Balloon office rendered a

consolidated telephonic report daily to G-2 and G-3 of the corps and to the Commander Army Balloons. The Adjutant at each Corps Balloon office made miscellaneous reports, written and telephonic, at varying periods, to G-2 and G-3 of the Corps and to the Commander Army Balloons. The assistant in the office of the Commander Army Balloons prepared memoranda throughout each day for distribution to the Chief of Staff, Information Officer and Operations Officer at Army Air Service Headquarters.

Divers reports and specialized matters were rendered to various authorities. Hostile aeronautics were reported by designated companies to contiguous D. C. A. antenna. Hostile balloons in ascension were reported by the Commander Army Balloons to the First Pursuit Group. Confirmation of enemy planes brought down by our aviators was given to the squadrons, for the record of pilots concerned.

(B) Regulation of Fire.

The weather during the first two days of the attack prohibited the regulation of Artillery fire. The balloons, on subsequent days, however, conducted important and successful adjustments. On September 16, the 2nd Company regulated 157 shots for batteries of 155's; on the same day, the 3rd Company adjusted 118 shots for batteries of 155's; on the same day, the 11th Company regulated 128 shots for batteries of 155's.

III

CASUALTIES AND LOSSES

The casualties and losses during the offensive may be summarized as follows:

Sept. 12—Balloon No. 10. Balloon was driven into the trees by a high wind and so torn as to render it unserviceable. First Lieut. David G. Boyd had his leg broken and back sprained when the basket was thrown against the ground.

Balloon No. 12. The cable of the balloon was snapped by a strong wind when the balloon was close to the ground. One parachute was smashed by being crushed against the ground. The balloon was last seen at an altitude of 3,000

meters, traveling towards the enemy lines. First Lieut G. W. Hinman, A. S., U. S. A., and First Lieut. Roland S. Tait, A. S., U. S. A., remained in the basket.

Sept. 13—Balloon No. 20 (French.) Balloon was punctured by diving into a tree.

Sept. 14—Balloon No. 5. Balloon was burned by an enemy plane.
Balloon No. 2. An American plane (Salmson) collided with the cable of balloon No. 2, wrecking the plane and killing the observer and pilot on the plane, but causing no appreciable damage to the balloon.

Sept. 15—Balloon No. 1. Balloon was burned by an enemy plane.
Balloon No. 2. Balloon was burned by an enemy plane.

Sept. 16—Balloon No. 9. Balloon was deflated by enemy shrapnel.

IV

RECOMMENDATIONS

The experience in the Saint Mihiel offensive suggests the following recommendation:

The assignment of balloons to Army Artillery, as such, should be abolished. It is recommended that all balloons, under the jurisdiction of the Army, be assigned directly to corps.

The necessity for providing a channel through which reports can be transmitted **promptly** requires that the reports come through an office which is in more intimate touch than Army Headquarters can be, with balloons on the line. Information obtained must be acted upon at once. Delay of an hour, in the effort to secure connection through main centrals, renders the information worthless. All balloons should be connected by direct line to the balloon central of the sector, so that the value of the balloon's observations may be immediately utilized.

The mission of all balloons in the sector is, fundamentally, the same. The mission is two-fold: surveillance of the sector and adjustment of fire.

There is no distinction, in method and aptitude, between an

observer's watching matters of interest to Army Artillery and an observer's watching matters of interest to G-2 of the Corps. Ludicrous it is to assume that a balloon can look only for things of importance to the Army, shutting its eyes to things of importance to the Corps. The balloon must see everything and should report everything to one central balloon group office. That office should be held responsible to determine whether the information is of value to Army Artillery or to Corps Artillery, to G-2 of the Army or to G-2 of the Corps.

There is no distinction, in process and function, between adjusting fire for the 155s of Corps Artillery and adjusting fire for the 270's of Army Artillery. There is no distinction between spotting objectives for Army Artillery and spotting objectives for Corps Artillery. The work is identical.

The present designation of Army balloons, as such, creates this double paradox of permitting the Army balloon to be idle when the Army Artillery does not fire and, on the other hand, of compelling the Army balloon to reach over into the sector of other balloons where Army Artillery batteries may be situated, attempting to regulate their fire on an exaggerated Balloon-Target-Battery-Target Angle.

The balloons in a Corps area should be distributed territorially, not tactically. The balloon should be identified with a sector, not with a command. The balloon should see everything and do everything in its sector. The balloon should regulate every piece of artillery, of whatever calibre, in the sector. The balloon should observe everything in the sector, whether it be the relief of enemy troops—a matter of interest to G-2 of the Corps—or whether it be a 42-centimetre gun in action—a matter of interest to the Army Artillery.

The function of every balloon in an operation should follow this defined rule: It should see everything directly in front of it, and no more. It should regulate for everything directly behind it, and no more. Thus will efficiency and harmony of activity be augmented.

JOHN A. PAEGELOW,

Major, As. S., U. S. A. Commander Army Balloons, 1st Army.

PLAN FOR BALLOONS

Balloon Wing 4th Army Corps, A. E. F., A. P. O. 731—A.

9 September, 1914

1. The Assignment of Balloons is as follows:

9th Balloon Company__________ 1st Division
3rd Balloon Company__________42nd Division
43rd Balloon Company__________89th Division
69th Balloon Company__________4th Army Corps
10th Balloon Company__________1st Army

2. Location of Balloon Companies and Ascension Points.

Balloon No. 9—

Chart Room ______________________L 4230
Ascension Points __________________L 3741
Advance Point ____________________L 3569

Balloon No. 3—

Chrt Room _______________________L 7056
L 7056
Ascension Point ___________________L 7959
Advance Point ____________________L 7271

Balloon No. 43 —

Chart Room ______________________M 1436
Ascension Point ___________________M 1050
Advance Point ____________________M 1085

Balloon No. 69—

Chart Room ______________________L 6450
Ascension Point ___________________L 6351
Advance Point ____________________L 6960

Balloon No. 10—

Chart Room ______________________M 0641
Ascension Point ___________________M 9948

3. Line of Advance.

Balloon No. 9 will advance from Raulecourt to Bouconville to Kivray-et-Marvoism to Richecourt.

Balloon No. 3 will advance

(a) To Mandres via Mamonville to Beaumone to Seiche Prey to St. Baussant; or

(b) Direct to Mandres to Beaumont to Seiche Prey to St. Baussant.

Balloon No. 69 will follow Balloon No. 3 and the two balloons will maintain proper intervals between any advanced ascension points, chosen as circumstances dictates.

Balloon No. 43 will advance along the road to Aneauville to Bernecourt to Flirey to Essey-et-Manizerais.

Balloon No. 10 (1st Army) will advance along same route as Balloon No. 43.

4. Liaison.

(a) Telephonic Liaison.

(1) Each balloon will have direct telephone communications with the unit to which it is effected. In case of advance Balloon Companies will make every effort to effect direct communication with the unit to which it is affected, but it should be understood by those units (Division Headquarters and Artillery Units) that often the balloon cannot find the P. C.'s of their units and if a line is run from the P. C. of the unit to the winch (following the balloon, which can be seen in ascension), much more effective and faster communication can be established.

(2) Each balloon must determine what the next position of the Advanced Artillery Information Service Central will be and establish direct communication with that central.

(3) Each balloon must establish liaison with an artillery unit to which **direct** telephone communication must be established for fire on fugitive targets—preferable with 155 G. P. F.'s. Divisional balloons should also establish each liaison with the Corps Artillery. All balloons must make personal liaison with the Artillery unit in their vicinity and discover the next probable position of the Artillery Battalion to which they have been effected for fugitive target work. If possible the Artillery should run lines to the balloon. They can see the balloon and run to the winch. The balloon cannot see them.

(b) Personal Liaison.

(1) With Artillery Units.

The closest possible personal liaison must be kept up with the Artillery in the vicinity of the balloon, and especially with the unit to which effected for fire on fugitive targets.

(2) With Divisional Staff.

Observers must seek out Division Headquarters and give them the benefit of any information they have obtained in the basket.

Often things that seem immaterial to the observer are of importance to the Divisional Staff and this can only be discovered by personal liaison.

(3) With Aviation.

When transportation permits, personal liaison made with aviation to get benefit of their observation and to compare observations made during the day.

Each balloon will maintain its wireless sending and receiving station and will be equipped with a wireless wave length and code call.

NOTE—Each balloon will have direct communication to Corps Central or through next balloon to Corps Central and from there to P. C. of Balloon Wing, C. O.

PAUL PATTERSON,
Capt. F. A., U. S. A.

File
CAS., B.S. (2)
Maj. Paegelow.

NOTES ON BALLOON OPERATIONS DURING THE ST. MIHIEL ADVANCE.

Headquarters Balloon Section,
Air Service, A. E. F.

MEMORANDUM FOR
Balloon Branch, Training Section,
Division of Military Aeronautics,
Washington, D. C.

The following notes on the balloon operations during the St. Mihiel and Verdun offensives were made at the front during the course of the two operations and an endeavor has been made to clearly set forth the fact that, during an advance, **balloon tactics** are **materially different** from those employed in normal trench warfare.

1. In this advance, due to poor weather conditions and to the fact that the forward movement was so rapid, there was but little opportunity for the balloons to co-operate with the artillery in the adjustment and control of fire. Prior to the advance, however, in the artillery preparation, they were engaged in this work and as soon as the German artillery was placed in position to check the advance the artillery role of the balloons was resumed, and numerous reglages were undertaken with very good results.

2. During the actual advance the balloons were constantly being moved forward and much valuable information was transmitted to the General Staff of the Corps and Division. The attached copy will illustrate the nature of the information sent in. It must be borne in mind that during an advance, when all arms are being hurried forward, including artillery, there it but little opportunity for the balloon to function in its role as an instrument of artillery reglage. However, there is so much artillery work prior to the actual advance and so much which is necessary to check counter attacks after the forward movement has stopped, that the balloon can perform a very important artillery function during the period which may be considered as that during which the attack is in progress. During the preliminary operations, of course, the role of the balloon is definite and should not vary greatly from that employed under normal conditions, viz: artillery reglage.

However, when the infantry advance starts, all this is changed. The action is comparatively rapid, and to properly perform its

function the balloon should **advance** well toward the front lines, **keeping constantly in view of the infantry advance.** No matter how rapidly the latter moves forward the balloon should make an effort to keep up. In order to do this it may be necessary to arrange a priority on road space with the Chief of Staff of the Corps in which the balloon is operating. Otherwise a balloon company may find itself unable to move forward for days on account of the great congestion there is on the roads. Immediately after an advance everyone is trying to move his equipment forward and no consideration will be given to balloon units unless advance arrangements have been made to assure the balloon a place in the line. This place should be as near as possible to the front. In the St. Mihiel advance one balloon was practically out of operation, being twelve miles or more behind the front on the third day of the advance. This happens simply because the Company Commander **waited for an order which never came,** or came too late to be of any use. The balloon was up and the observer was faithfully attempting to perform his duties, but no telephone communication existed with any office of the Corps, nor was there anything of value to observe in the field of view of the balloon.

If the advance is successful the enemy will, in all probability, immediately withdraw his artillery and during this time there should be little or no danger of any attempt on his part to bring down the balloon by shell fire. The balloon should therefore be reasonably safe from artillery fire in a position quite close to the lines. In the St. Mihiel advance one balloon (American) was moved to a position but little over one kilometer in rear of the consolidated front, as reported to the General Staff. Very few of the balloons were over four kilometers in rear of this line and at no time was there any attempt on the part of the Germans to use their artillery against the balloons. In fact, the fire of German artillery was hardly noticeable at a distance of five kilometers behind the front lines.

5. The activity of enemy airplanes was, however, of considerable importance, insofar as concerned the balloons. They seemed very persistent in their attacks on balloons, one plane in particular, making three attempts to burn a balloon, and failing in this, due to an anti-aircraft barrage, it attacked the adjoining balloon with successful results. It may be stated that this apparently unusual activity on the part of German airplanes toward American and French balloons, has been quite noticeable throughout the

summer. It seems evident the **Germans are convinced that hostile balloons are performing a very important function**—so important, in fact, that most energetic measures must be taken to destroy them.

The danger to the balloon from hostile airplane attacks is most felt when the sky is patched with clouds at comparatively low altitudes. The plane flying at so great a height as to be invisible in the open sky, will, on passing over a cloud, descend into it and then immediately dive through it to the nearest balloon. When but a short distance from the latter the plane will open fire with incendiary bullets and unless the greatest vigilance is observed on the part of the balloon personnel, the balloon will be burned. A most vigilant lookout party is therefore necessary and as soon as the plane is seen descending through the clouds, the observers are directed to jump. The balloon is then rapidly hauled down and the machine guns with which the companies are provided, are directed against the plane. In addition, if at any time a German plane is seen approaching a balloon, the latter is hauled down to an altitude of about **three hundred meters,** the machine gunners stand by and arrangements are made to immediately change the position of the balloon (either by moving the winch or through the medium of the maneuvering tackle.) The observers prepare to jump, if necessary. If there is sufficient anti-aircraft artillery in the vicinity to immediately put up a barrage between the plane and the balloon, and if, in addition, the American and French chasse (pursuit) planes have gained a decided superiority in the air, the balloons should be well protected and the danger from hostile airplanes greatly lessened.

4. Considering the duties of the balloons during the advance of the infantry, too great attention cannot be given to the prompt transmission of all information. As stated before, there will be but little opportunity to regulate artillery fire. However, this is the particular time when the General Staff of the Corps or Army is most anxious to obtain information and all reports are most welcome, **provided they are accurate, or if not accurate the observer so states in his report.** In general it would seem better for the observer to report only the information of which he is reasonably certain, omitting that which he **thinks** accurate, unless he is definitely asked for information on this subject. In the latter case he should give it as his opinion only and state the reasons why he cannot be sure on the matter. As an example,

during the St. Mihiel operations, a report was sent in by an observer to the effect that a certain town within the American lines, was in flames. Later information disputed this report and it seemed that the balloon observer, having seen considerable smoke arising from the town, without further investigation, simply sent word that the town was burning. He should have only reported that he saw smoke in several places. The Intelligence Section of the General Staff receive reports from various sources, all of which are co-ordinated and a definite Summary of Intelligence is compiled. If, however, there are conflicts in the reports, it requires considerable time and still further reports until a correct estimate can be determined. It may, therefore, be seen that the **balloon observer should only report what he is sure of,** unless he deems the information of sufficient importance to warrant sending in an indefinite report—in which case he should clearly indicate that the report is not definite.

5. During the advance the balloon endeavors to maintain its telephone connections as long as possible, but a continuous telephone liaison is, of course, impossible. However, whenever progress is halted, even if only temporarily, every effort should be made to establish telephone communication with the office (P. C.) of the organization to which the balloon is attached—as a rule the Corps or the Division. During the periods when there is no telephone communication, reports from the observers should be noted, indicating the time when made, **and every possible means employed to transmit them to their proper destination.** Transmission of information reports by courier has not been found very satisfactory as a rule, on account of the unusual delay involved.

6. During the St. Mihiel advance considerable employment was made of the balloon **at night,** and each night there was at least one balloon in the air. Artillery reglage at night is practically impossible, although the balloon should be prepared to attempt it if necessary. (One balloon it the St. Mihiel advance reported an artillery reglage at night.) The principal role of the night balloon is a general surveillance of the sector, observation of battery flashes and shell bursts, fires, Bengal signals, etc. Telephone communications are established before nightfall and reports are sent in as promptly as possible. Where there is considerable activity on the part of friendly bombardment squad-

rons (night) care must be taken to keep the balloon at an altitude of not more than five hundred meters. This precaution is taken to avoid the danger of a plane colliding with the balloon or the cable. In this connection it may be stated that even during daylight, it is often very difficult for the pilot of the plane to see the cable. During the St. Mihiel operations an American plane struck a balloon cable, with fatal results to both pilot and airplane observer. The ordinary danger cone does not seem to be sufficient in size, and although two are invariably attached to the cables, it may be that steps will have to be taken to replace them by a large flag of a distinctive color.

7. As stated above, German airplanes are particularly active in their attacks on American and French balloons. The importance of careful and **intelligent sky watching** can, therefore, be hardly overestimated. In spite of the fact that ample protection in the form of anti-aircraft batteries and chasse planes may be provided, and efficiently operated, it is certainly possible for an efficient and energetic German pilot to get through the anti-aircraft barrage and cordon of chasse planes, to a position where it is a comparatively easy matter to destroy the balloon, provided the latter is not hauled down well in advance of the approach of the plane. Clear or partly cloudy days offer the plane the best opportunity. However, the plane can be seen at a considerable distance and at approximately ten kilometers (horizontal) the distinguishing features can be determined if there is a fair visibility. In each balloon company there is a squad of one corporal and seven or eight privates, known as **"lookouts."** When the balloon is up it is the sole duty of this squad to observe the sky and report the appearance of **every** plane seen. A most careful observation of the plane is kept and the direction in which it is proceeding, it always known. In addition the well-trained "lookout" can always ascertain from the general contour of the plane, the presence of certain salient features, the empennage, struts, etc., whether or not it is an Allied or German ship. The procedure is therefore as follows:

A plane (or group of planes) is seen in the sky, say at a distance of ten kilometers. The "lookout" carefully watches this plane, and particularly notes the direction in which it is proceeding. If it is approaching the balloon he keeps it under careful observation. As soon as he is able to determine (from its appearance to the type (Whetrer Allied or German) he so

reports to the Maneuvering Officer. If an Allied plane the observation is abandoned and the "lookout" devotes his attention elsewhere. **If a German plane** the **balloon** is immediately houled down to a position not greater than 300 meters. The **machine gun details** are given the order to stand by, as well as the description and designations of the hostile plane. The **winch operator** starts his truck motor and prepared to immediately move out. In case the winch cannot be readily moved the **maneuvering tackle** is placed upon the cable and the detail assigned to this prepare to immediately change the position of the balloon. The guns are trained on the plane and kept there. The **observers** are informed of the approach of the plane and make preparations to jump. If it becomes evident that the plane is approaching the balloon with intent to destroy it, the balloon is immediately hauled down with all possible speed and, at the same time, the position is changed either through movement of the winch, or if this be not practicable, by means of the maneuvering tackle. If the plane dives at the balloon before it can be hauled down, the observers are directed to jump and the machine guns open up when the plane comes within range. In case the hostile plane is merely passing on another mission, the balloon is kept at its altitude of 300 meters until the plane disappears. **So long as it is visible it is kept under constant observation.** In case two or more hostile planes are observed at different positions they are all kept under observation in precisely the same manner as is a single plane. In addition the appearance of a single hostile plane or group does not mean that observation of other parts of the sky are abandoned. While one or more members of the "lookout" party are engaged in watching the hostile plane or group, the other members are devoting their attention to other parts of the sky in an endeavor to locate other planes—Allied or German.

The importance of a **thorough training** for the members of the "lookout" party is therefore evident. Furthermore, it is believed that a large part of this training can be given in the Balloon Schools in the United States. A sheet (prepared by the General Staff) showing the common types of German planes, is being forwarded, as well as the pamphlet "Silhouettes D'Avions." The latter gives an accurate conception of the appearance of **Allied** planes but not of German planes. The types shown on the G. S. sheet will, however, give the correct and up-to-date appearance of the German types. The trained "lookout" should be so

familiar with the outlines of the planes indicated that he may recognize them as soon as their outlines against the sky becomes definite. In training these "lookouts" in the United States a method suggested is to first select men of considerable intelligence for this work and then require them to draw, first from the diagram, and then **from memory,** the silhouette of **all** Allied and **all** German planes in the three positions shown. This should be done with absolute accuracy before a man should be qualified as one of the "lookouts" of a balloon company. In order that the man may retain in his memory the appearance of the different types of planes, the training should be continued in the company, which should be at all times provided with at least six sheets of both large sheets and pamphlets. Members of the "lookout" party should be periodically examined on this subject at least up to the time that the company arrives in France. It is, of course, realized that if a real training is given "lookouts" in the United States considerable time and attention must be devoted to it. However, the vital necessity of efficient sky watching demands all the time and attention that can be given.

8. In applying the lessons of the St. Mihiel advance to the training of officers and organization of the Balloon Service in the United States, it is evident that, not only must the observer be thoroughly trained, as hitherfore, in the work of artillery reglage, but in addition the entire organization—both officers and enlisted personnel—should be instructed as far as possible, in the use of the balloon as an instrument of general information, particularly in an advance. The latter, while probably of secondary importance, is extremely essential if the balloon is to attain its maximum value at the front.

In training companies in the United States it is therefore suggested that every effort be made to simulate as far as possible, the conditions which pertain at the front during the advance. It is obvious, however, that these conditions can only be approximated in the United States or, in fact, anywhere except at the front. Organizations in training in the United States should, nevertheless, be sent out periodically and at frequent intervals from their stations, spending at least one week on the road. Locations of the various control stations (P. C.'s) such as Headquarters, Group Commander, Division Artillery, Corps Artillery, Corps Headquarters, etc., should be represented. Advanced balloon positions should be selected, first from the map and later

by personal inspection. The organization should, as a rule, travel by night, breaking camp after dark. The balloon should be kept inflated and as soon as a new position is reached preparations for an assent should be made. (It is only by continued practice that a balloon company can prepare itself to quickly reach its new position and to put the observer in the air within the shortest possible time and with the least difficulty.)

Maps of the sector of operations should be prepared by drawing lines to represent the front line trenches and enemy positions. Information should be sent the observer (or officer responsible) as to the nature of simulated enemy positions of importance in the area in which the balloon is operating and also of the general nature of its mission. The observer should be required to report on all matters of a military nature in his sector, such as troop or train movements, fires, battery flashes, bursts, signals, etc. Arrangements should be made whereby these reports should be checked as to position and time. The efficiency of the work of any organization could be determined from the time at which the information is sent, its accuracy, and the amount of activities observed. The matter of prompt dispatch of information is, of course, dependent upon the mobility of the organization and the promptness with which the communication service is established. Organizations should be thoroughly trained in quickly breaking camp, moving to a selected new position, establishing communication, and putting the balloon in the air. In order to avoid an ideal condition, obstacles of various degrees of difficulty should be introduced, such as passages through woods, overhead wires, etc. Certain companies at the front have found it necessary to simply move their balloons and winches forward, leaving all other equipment at the rear until such time as an opportunity was afforded to bring this equipment up. Such conditions should be simulated as far as possible in the United States. Organizations should be provided with all necessary telephone equipment and should be trained to quickly establish communication with certain designated positions in rear. They should understand just what are the essential points to which connections are necessary and should be taught not to connect up to any unnecessary stations. In the St. Mihiel advance balloon companies took every opportunity to connect up to any line which had been established, provided permission could be granted to connect in. Even though there was no possibility of the artillery being able to operate

within several hours, telephone connections were established for general information purposes. The lines to the artillery central were put in later.

In the training of the observer to obtain information from general sector surveillance, it should be remembered that it is not necessary, nor is it as a rule advisable, for him to report on matters outside of the sector to which he has been assigned, although he may be in a position to see what is going on in adjoining sectors. If he does his work properly he should have all that he can handle to observe what is going on in his own sector. In addition, reports coming from sources located all along the front and pertaining to but one small area, are very liable to lead to unnecessary confusion when they reach the Intelligence Section of the General Staff. In the St. Mihiel advance, during the period when the infantry was advancing, an attempt was made to have all balloons kept in ascension and to have each balloon report on all matters within its own sector. This, of course, lead to duplication of reports from different balloons. While there seemed no serious objection to this, inasmuch as the second report was simply a confirmation of the first, nevertheless it seemed to be the general opinion that but one, or possibly two balloons per Corps could take care of all sector surveillance during the infantry advance. This seems a matter which should preferably be left to the judgment of the Group Commander. Once the advance has halted, as many balloons as are necessary for artillery reglage should be sent up, provided each has a definite mission. At this time it seems probable that the service of general information can be provided by one balloon per Army Corps.

Too many balloons on a sector of the front is liable to introduce a factor of danger, inasmuch as they present a very tempting invitation to the German aviators to come over and try to destroy some of them. In the St. Mihiel advance it was found that the number of balloons necessary at the beginning of the drive was in excess of what was needed after the final objective had been reached. The reason for this was that while at the beginning of the drive the front was along the two legs of a triangle, at the end it only occupied the base of the triangle. Consequently as the balloons moved in from the side, they came nearer and nearer and finally four balloons were reported in an area of not more than four kilometers. While this report was not quite accurate the balloons were nevertheless so close that a

German plane was able to destroy one and immediately destroy a second before an efficient anti-aircraft barrage could be effected. It was then decided to put up but one balloon per Corps, the others to be in readiness to ascend whenever required to work with the artillery.

9. No attempt has been made herein to prescribe a course of training for balloon organizations in the United States. A very brief outline of the general nature of such training has been indicated in order to point out the fact that the modifications in balloon tactics brought out by the St. Mihiel advance, necessitate certain modifications in the training of balloon organizations which can and should be put into effect in the United States. With an experienced and efficient corps of instructors it is believed that there should be no difficulty in introducing into the course now prescribed at the Balloon Schools in the United States, the changes necessary to meet as far as can be met there, the new requirements imposed upon balloons during an advance.

10. From the description of balloon operations outlined above it is not to be inferred that the role of the balloon has been materially altered, when an army changes its tactics from trench warfare to offensive operations. The main role of the balloon is and will be artillery reglage. It is only during the period when the infantry is advancing through the enemy lines of defense that the balloon tactics are altered. As stated above, during this period the artillery is also on the move or is preparing to do so and the necessary system of communication is broken. In the St. Mihiel advance it was during this period that the large area was recaptured and this operation occupied but two days. Immediately upon gaining their objective the infantry advance was halted, German counter attacks commenced and German artillery was in action. Our own artillery was within a very short time in readiness to open fire upon definite objectives and were calling upon the balloons for reglage. The role of the latter then reverted to its former one and the companies were in most cases ready to undertake the work of reglage as soon as called upon to do so.

GEIGER,
Lt.-Col. Air Service, U. S. A.

BALLOON WING,
FOURTH ARMY CORPS, AMERICAN E. F.
A. P. O. 775.

I October, 1918.

REPORT OF THE BALLON WING COMMANDER ON THE OPERATIONS OF SEPTEMBER 12, 1918.

GENERAL PLAN.

Field Order of the Fourth Army Corps stated that the plan for the First Army was to reduce St. Mihiel salient by two simultaneous attacks, one from the south with the Fourth Army Corps on the left and the First Army Corps on the right, and one from the west by the Fifth Army Corps. The Second French Colonial Corps was to operate between Fourth Army Corps and Fifth Army Corps. Artillery preparation of four and one-half hours.

The starting line for the Fourth Corps was the general line—Richecourt—one-half kilometer south of Lahayville—north of Bois de Reimeres—one-half kilometer north of Flirey—one kilometer north of Limey. First Division on left—42nd Division center—89th Division right. For balloons, they were to make such preparations that they could follow operations of infantry and artillery; for divisional balloons along divisional axis, and for Corps balloons along Corps axis.

PREPARATIONS AND INSTRUCTIONS.

On arrival of Balloon Wing Commanding Officer in the Fourth Corps, 9th Company and the 43rd Company were already in position, previously determined. In consultation with C. A. B., 1st Army, and Lieut. Berard, 3rd, 69th (Corps Balloon) and 10th (Army Balloon) were assigned positions and lines of advance as shown in attached Plan for Balloons.

Verbal instructions had been given that each company commander should make a reconnaissance as far forward as possible to discover what difficulties were to be overcome in movement forward and all company commanders had carried them out. Also, advanced ascension points were determined upon, with winch position determined and prepared. Arrangements were made with Artillery Information Service so that each balloon could run direct lines from its telephone central to Advanced A. I. S., which had direct line to Corps Headquarters, thus enabling Balloon

Wing Commanding Officer to keep in touch with each company and also with Corps Headquarters.

MOVEMENT OF BALLOONS.

(1) The balloons were to move on divisional axis—the Corps Balloon (69th Company) along axis of center of sector—that of the 42nd Division—following up the 3rd Balloon and keeping a proper interval between their ascension points. The 10th Balloon not to move until Chief of Army Artillery was about to move his artillery forward.

(2) The above disposition was made because of the fact that the sector of the Fourth Corps had three main roads all of which converged at Essey. It was found that the greatest difficulty encountered was congestion of the roads after the first day of the attack, September 12, 1918. Congestion was caused by large amount of artillery and supplies moving, together with fact that roads had to be repaired between former lines before movement was possible. The companies adopted different methods of advance as occasion demanded. Where movement forward was about to take place and balloon was in ascension, one echelon went forward with 80 tubes of hydrogen and all equipment except that necessary for operations. In case no ascension was possible at the time of movement, the companies moved as a whole. The telephonic communication first established was, as anticipated, through A. A. I. S., though this was held up some six hours, due to the fact that A. I. S. waited for Corps Artillery P. C. to move and also due to congestion. Hereafter the intention is to move this A. I. S. central without waiting for Corps Artillery P. C., and it is anticipated that quicker communication will thus be established.

Wireless:—The Field Order did not specify the wireless wave length for the balloon companies, though their code calls were given. Balloon Wing Commanding Officer attempted to get their wave lengths up to the last possible hour, but could not discover what they were from Signal Officer, 4th Corps.

(3) The morning of the attack, September 12, 1918, was very poor for observation work, despite which all balloons were in ascension for some time, with the exception of 10th Company, which had an accident while ascending, on account of high winds and being too close to trees. The advance of the balloons started the same day in as much as visibility was very poor.

LIAISON.

Great difficulty was experienced by all company commanders in getting in connection with artillery units, even though they had all been assigned to distinct units of artillery. This was owing to the fact that they had no definite idea of where P. C. would be in advance. Before movement, many artillery units run wires direct to balloons. On good days for visibility, the 3rd, 69th and 10th balloons carried on some adjustments and sent down to A. A. I. S. some very valuable information. During the preliminary stages of establishing the line after the army objective was reached, the greatest part of information was received from balloons as the Sound and Flash Ranging Stations were not operating. It seems that greater use can be made of the wireless during these periods when telephonic communications are being established. The information passed from A. A. I. S. to A. I. S. and was handed at once to G-2 of the Corps, as all sections of the Corps were at the same place and so in constant liaison. Did not seem that our balloon commanders realized enough the importance of keeping their Division Headquarters informed as to enemy movements, though they did send such information to A. A. I. S.

ARTILLERY MISSION.

During the period, September 12th to 17th inclusive, the five balloons carried on some eighteen adjustments, most of them on the 15th and 16th, when the stabilizing period was on. During the first few days the visibility was very poor, but from personal inquiries made by Balloon Wing Commanding Officer, it was found that the artillery was very much pleased with the work of the balloons, when they had a chance to work. The 9th Company advanced too far forward, so they were out of it during the days mentioned. Ninth Balloon was deflated once on account of high wind and poorly chosen bed, and a second time because of shelling and machine gunning by German planes.

REMARKS.

(1) Duties of Balloon Wing Commanding Officer: The Corps Headquarters were moved forward one day before the attack and Balloon Wing Commanding Officer had room enough for himself only, in space assigned to C. A. S., 4th Army Corps. A line was run by the 43rd Company from his station to a central connected to all five companies. This line was very useful before

movement, but entirely useless after movement began. Balloon Wing office remained at rear echelon of the Corps. By remaining at Corps Headquarters the Balloon Wing Commanding Officer determined what progress attack made and approximate lines through A. I. S. and G-2. The difficulty was to get the information to Company Commanding Officers. On movement Company Commanding Officers must use best judgment following the axis laid down and acting in accordance with orders from their Divisional or Corps Commanding General. It seems to be absolutely essential that a Balloon Wing Commanding Officer be stationed at Corps Headquarters during an attack, both to give information and to obtain information, but he must also keep in touch with the companies to give them the benefit of the information obtained and to find out whether or not they have chosen proper locations and are making proper liaisons. In this attack it was impossible to get up to companies until morning of September 14th, owing to extreme traffic congestion.

(2) Company Commanders: Should discover so far as possible beforehand what is best route of advance and how to get into communication with Division and Artillery most quickly. During advance, three balloons were deflated on account of high winds. Appears that some accidents of that sort may be avoided by Company Commanders using more care during advance in selecting place for a balloon bed and getting a place which affords protection from wind and from German observation, in order to avoid shelling.

(3) Observers: Our observers have been at a great disadvantage in making liaison on account of the lack of light transportation. Also many of the companies have only two observers. The French are now demanding five observers to a company, which number does not seem too great if the greatest efficiency is to be obtained. My opinion is that best observers, as a rule, are those who have first had training at the front and then taken courses at U. S. Balloon School.

(4) Maneuvering Officer: Some of our companies were forced to use observers to do the maneuvering. Would be better if each company had one maneuvering officer plus one student maneuvering officer, who could relieve maneuvering officer and act also as supply officer during his training period.

(5) Personnel of the Companies: Personnel all showed

great willingness to work, some of the companies working two to three days and nights in succession. Chart Room specialists as a whole do not have enough experience as yet. Also should be taught something about artillery in order to talk intelligently when acting as secretary during adjustments.

RECOMMENDATIONS.

I. Supplies.

(a) Transportation.

Each company should have, in my opinion, the following transportation:

1. Eight 4-ton trucks.
2. Three 1 1-2-ton trucks (Fiat or Dodge or Ford Ordnance trucks.)
3. One rolling kitchen.
4. One chart room trailer.
5. One water tank trailer.
6. Three motorcycles with side cars.
7. One passenger car.
8. One winch.
9. One tender.

Also in order to obtain mobility which will be necessary next spring and summer, two companies in each Corps, if possible, should have, instead of eight four-ton trucks, six four-ton trucks plus four four-ton trucks, each of the last four equipped to carry 40 tubes of hydrogen. The companies were and are greatly handicapped by lack of transportation—thus greatly impairing their efficiency. This is especially true as regards light transportation for liaison and courier work. Only one company operating in this Corps, the 10th, had its full equipment of motorcycles; the others either had none or at most, one. Sixty-ninth Company, at present, has one motorcycle and six two-ton trucks. That is all the transportation with the company.

(b) Balloon Supplies.

My own opinion is that Park Companies should be organized to take care of all possible balloon supplies; one company for each Army Corps, if possible, if not, one for every two Corps. The Park should be stationed at a convenient distance from all the companies and be entirely mobile, having

a larger base further to the rear. These Park Companies could be located near enough to rail heads to take care of hydrogen supplies.

(c) Rations.

It should be arranged so that during movement the companies can draw supplies of gas and rations from the unit to which attached, in order to avoid such a great amount of hauling from Corps rail-head.

II. Personnel of Companies.

(a) That number of observers be increased from four to five and that companies should not be sent to the front without observers who have had experience on the front. At the very least one observer should have had previous experience on the front.

(b) It is absolutely essential that each Company Commander should have had some experience on the front before bringing up his company. In a month's time with the training obtained in the United States, he can learn a great many things which would save his company much lost time. It could be done by sending Company Commanders to the front and attaching them to old companies for one month.

(c) That it be insisted on that companies in S. O. S., follow maneuvering regulations adopted by C. A. S., Balloon Section, and that they be thoroughly trained in them before being sent to the front.

(d) That a student maneuvering officer be assigned to each company. After qualification, to be sent to United States Balloon School and relieved by another student, so that each company has continually on hand someone to relieve maneuvering officer. Good maneuvering officers seem to be hard to find and greater efforts should be made at the United States Balloon Schools toward developing that branch of instruction.

III. Balloon Wing.

(a) Balloon Wing to have nothing to do with supplies except in way of consultation with Commanding Officer of Park Companies.

(b) Balloon Wing Commanding Officers's duties to comprise liaison with Corps Headquarters, supervision of location of com-

panies and obtaining information to pass on to the companies or to Army.

(c) Balloon Wing Company to be cut down to, office men to handle reports, a cook, and enough men to handle transportation. Transportation to include:

One touring car,
Three motorcycles with side cars,
One Fiat truck,
One Dodge Ordnance truck.

This on the basis that Wing Company to handle no supplies at all for companies, so as to enable Wing Company to be a part of Corps Headquarters, which seems to be absolutely necessary for efficiency. Wing Company then to be cut down to twelve to fourteen men instead of forty.

Adjutant of Wing Company necessary to handle statistical and information reports, and to command the small detachment necessary—also to act as Commanding Officer in absence of Wing Commanding Officer.

PAUL PATTERSON,
Capt. F. A., U. S. A.

Distribution
GAS, Balloon Section, (2)
CAB, 1st Army
U. S. Balloon School
File

NOTES ON PREPARATION FOR AN ADVANCE.

The following notes serve to indicate the preparations made by the Balloon Service of an Army for an offensive operation. They were made during the period in which the 1st U. S. Army was preparing for the **contemplated advance on the Verdun sector.**

Duties of Wing Commander, Etc.

1. In preparing for an advance a certain shift of the balloon organization is, of course, necessary. Balloon Companies are, under normal conditions, spread out along the front held by the Army, some being in ascension each day, some deflated in their front line positions, and some held in reserve well to the rear.

When an attack is planned on a certain sector of the front it will be necessary to concentrate the balloons in rear of this sector. As many balloons as can be used are so concentrated. However, it will be found in many cases that, due to a number of

reasons, there is a limit to the number of balloons which can be used to advantage, and to bring more than that number to the sector to be attacked, will not only involve an unnecessary movement of personnel with its attendant difficulties, but would weaken the balloon strength on other sectors without any corresponding advantage. For example, on the Verdun sector the left flank was covered with very dense forests which made the passage of balloons almost impossible. A certain number of balloons could be used on this flank and were brought there. However, this number was limited by the fact that the balloons not being able to move forward promptly, the artillery activities on this flank could and should be covered by the balloons assigned to the Army Artillery.

The number of balloons to be brought to the front of the sector to be attacked will also depend upon the strength of the artillery involved in the attack. Under average conditions for ordinary fire control **one Divisional balloon** should be provided for every **twenty-five batteries.** For efficient reglage one **Divisional balloon** should be provided for every **fifteen batteries.** By fire control is meant simply the reporting of the fall of shots during the fire for effect. By reglage is meant the preparation of firing data through the medium of trial shots. Under practically all circumstances one balloon is provided for the Corps Artillery and heavy artillery of the Corps. In case the services of more than one balloon is found necessary for work with this artillery, Divisional balloons which are not extremely busy can be used.

For the Army Artillery the proportion of balloons is approximately **four balloons** for each **100 pieces.** In addition a certain number of balloons are held in reserve, this number depending upon the magnitude of the attack. In a large operation, where the operations should cover a number of days and involve a corresponding depth in advance, the number of balloons to be held in reserve should be great enough to permit of a balloon being sent to any part of the line and at any time when the development of the attack may require its presence. Balloons to be used for this purpose are assigned to companies held in reserve and are usually deflated, although if a reserve position is found from which a balloon may be moved to any part of the line while inflated, and with but little difficulty, it may be advisable as a matter of economy in time to inflate the balloon.

These reserve balloons are not to be confused with the

reserve supply of balloons, a sufficient quantity of which are to be provided **for each company** prior to the attack. The reserve supply is for the purpose of permitting a prompt inflation and ascent in case a balloon is burnt or brought down. In addition to the supply provided for each company, arrangements should be made whereby balloons may be shipped to locations which are accessible to any part of the front of the sector. It is also necessary to ascertain the number of balloons available in the Supply Depot, for assurance that there is a sufficient quantity to meet all possible contingencies.

2. The problem of an adequate gas supply is a matter of the utmost importance. Under normal conditions the gas tubes are shipped from the main depot to railheads which are convenient to positions to be occupied by the companies. The latter send trucks to these railheads and use this means of transport to bring the tubes to the balloon positions. Generally a considerable supply of tubes is kept on hand at the railhead depots. For example, in the St. Mihiel sector there were kept at a depot at Chaudeney a supply of from 1,500 to 2,000 tubes.

When the contemplated attack involves a shift of the Balloon Companies, it will, of course, be necessary to shift a number of tubes from the former depot to a depot in the new sector. This new depot should be selected with the greatest care. Special attention should be paid to the roads leading from the depot to the positions selected for the balloons. Railway conditions at the depot should also be examined, as well as the distance of the depot from the main supply of gas. Assurance is necessary that tubes can be promptly shipped from this point to the advance depot and that there are no obstacles which will prevent the prompt supply of gas to the advance depot. When a suitable point has been selected, as the location of the advance depot, arrangements should be made with the R. T. O. (Railroad Transportation Officer) for the prompt loading at the main supply depot, the prompt shipment to the advance depot, and the prompt unloading at the latter point. It is of the greatest importance that at least two days prior to the day set for the attack, enough tubes be provided at the advance depot to furnish sufficient gas to meet all demands which can be foreseen. This supply is in in addition to that which is carried by each company. (The latter should be checked in order to see that each company has sufficient tubes for one additional inflation, if

already inflated, or two inflations if deflated. If the width of the front demands it, additional advance depots should be provided, the number depending upon the width of the front and the number and condition of the roads in the rear of the lines bounding the sector. Each depot should supply gas to a certain number of balloons and care should be taken that each Group Commander and Company Commander knows the location of the depot which will supply gas to his organization. Care should also be taken that at each depot there is sufficient gas to supply all needs of the companies designated to call upon it for gas.

3. The careful selection of balloon positions is a matter which requires considerable study, not only by the Group Commanders, but also by the Wing Commander. The number of suitable balloon positions has a considerable influence upon the number of balloons which it is advisable to concentrate upon the sector to be attacked. On the other hand the number of balloons which the tactical situation and artillery strength demand, will determine the number of positions to be selected. The problem should be worked out from both angles and considerations as to tactical situation, artillery strength, terrain, roads, etc., should be taken into account before the balloon positions are finally chosen. In so far as relates to the present front it is extremely fortunate that, upon taking over the lines formerly held by the French, the American Balloon Service has the advantage of the knowledge of balloon positions in the possession of the former, through four years of warfare. It was found on the Verdun sector that the French had determined the most suitable sites for balloon beds, points of ascension, and balloon itineraries and locations for telephone centrals. At Verdun the French had prepared for an attack over the same ground as was occupied by the American Army. The Commandant of the French Balloon Service, who was assigned to the French Army in that sector, was therefore able to indicate directly the number of balloons which should be employed on the front of the sector, the number to be held in reserve, the location of balloon beds, ascension points, itineraries, telephone centrals and supply depots. This information greatly simplified the problem confronting the Commander of Army Balloons, 1st Army (U. S.), but nevertheless, it is of course not to be inferred that, even in a case where such complete information was available, the problem was disposed of without a very careful study on the part of the balloon officers of the 1st Army.

Also, assuming that the advance of the American Armies will be successful and continued, in the future, new terrain will be occupied and the front will finally reach terrain which could not be studied by the French. When such a period is reached, the information which can be supplied by the French will be extremely meager and the solution of the problem will be entirely in the hands of the American Balloon Service. It is, therefore, evident that it is only by a very careful study of the manner in which present problems are solved that American balloon officers will be able to work out a satisfactory solution of future problems.

After the number of companies to be assigned to the front to be attacked has been decided upon, and the balloon positions determined, a careful inspection of these positions is made, both by the Wing Commander and the respective Group Commanders. Each in his respective sector, the Group Commanders should familiarize themselves with the details of **each balloon position,** including the exact locations of the various **balloon beds,** the **ascension points,** the **available itineraries,** the most suitable site for **chart room, telephone central,** etc. Sites for the **company camp, machine guns, "lookouts," transportation park,** etc., should also be investigated. Group Commanders should also be familiar with the roads leading to the gas supply depot which supplies the gas for each company in their command and should personally inspect such roads to assure themselves that they are available and in fit condition for use. The front of the Corps sector should also be thoroughly understood by each Group Commander. In the case of each company each Group Commander should communicate the above information, together with any other information of value, to the Company Commanders serving under him, and he should be certain that his Company Commanders are fully informed thereon. If possible each Company Commander, accompanied by his Group Commander, should inspect the new position of his company prior to the movement of the latter. In most cases this will, however, be found impracticable.

In the case of the balloons assigned to the Army Artillery, the information regarding the balloon positions is communicated either directly by the Wing Commander or by one of his staff officers to the Company Commanders of the balloon companies assigned to duty with the Army balloons.

4. The matter of the most efficient assignment of the balloon companies available and necessary for duty on the new front, is one which rests with the Wing Commander. Assuming that the number to be assigned has been difinitely fixed, the Wing Commander must decide upon the assignment which will most efficiently carry out the mission which they are to perform. The number of companies to be assigned will depend upon:

(a) The number available.

(b) The tactical situation, viz: magnitude of the attack, width of the front, depth of advance, etc.

(c) The strength of artillery.

(d) The nature of the terrain in front and in rear of the line.

(e) The number of available balloon positions on the new front.

The assignment of companies to positions and units on the front will depend upon:

(a) The relative importance of the mission of each Corps.

(b) The mission of the Army Artillery and the nature of the work on which it is engaged.

(c) The relative state of training of the companies and their relative efficiency.

Usually the companies held in reserve are those whose training has been the least developed or whose general efficiency is the lowest. Companies assigned to the Army Artillery are, as a rule, not required to perform the careful and exacting work that is required by the Corps or Divisional balloons. However, it can readily be seen that a situation may develop whereby a reserve balloon company may be required to perform a very important mission. If such development is expected or probable, this reserve company should be one of the most efficient in the Balloon Wing. It may also happen that the mission of the Army Artillery may be such that very careful observation from balloons is required. In such case only well trained companies should be assigned to this duty. Another case may occur where the artillery mission of a particular Corps will be of greater importance than that of any other Corps, due perhaps to the activity of the enemy artillery opposite the sector of this Corps, nature of the terrain, etc. In such case the Corps in question should be assigned a greater proportion of balloon companies,

and these companies should, in so far as is consistent with general efficiency, be the most efficient in the Balloon Wing.

It will be found that due to the conditions under which the American Armies are operating, balloon companies will be in various stages of training while serving at the front. Some will have been on the line for many months, others will have only recently arrived from training stations. Some, through the efficiency of their officers, will be better trained than others, some may have more observers than others, and the state of the training of these observers will be in various stages. It is, therefore, only through the most intimate knowledge of the front to be attacked, and the relative training and efficiency of the balloon companies under his command, that the Wing Commander can make the intelligent assignment required for efficient balloon service, of the companies in his wing, and the transfer of observers where they are most needed. Similarly, the Group Commander must make the same assignments and transfers within the Balloon Group which he commands.

As an example, on the St. Mihiel front there were twenty-one balloon companies in the 1st Army. In preparation for the Verdun attack and after considering the various conditions existing on that front, it was decided to employ a total of nineteen companies, four of which were to be held in reserve. More companies could have been employed to advantage, but were not available. In the general shift of troops to the Verdun front one Corps was withdrawn and not assigned to duty there. It became advisable, therefore, to transfer the balloon companies which were assigned to that Corps—well trained and experienced companies—to another Corps which was assigned to duty on the Verdun front. It so happened that one of the Corps assigned to the Verdun front had but one balloon company assigned, and therefore the transfer of two of the best trained companies of the withdrawn Corps to the Corps referred to, was made. These companies were replaced by an experienced company acting as reserve on the St. Mihiel front, and by a company of only a moderate degree of training, and which had been acting as an Army Balloon Company.

5. In the preparation for an attack it may therefore be stated that in a general way the responsibilities resting upon the Wing Commander are the following:

(a) To thoroughly familiarize himself with the plan of opera-

tions in so far as he has access to the same. He should, in any case, know the location and width of the front to be attacked, the depth to which it is to be penetrated in order to accomplish the objective, the number of Corps involved, the sector assigned to each, the amount and caliber of the Corps and Divisional Artillery, the number of pieces and calibers of the Army Artillery, and the general nature of the objective. This last is of importance in so far as pertains to the instruction of the observers, regarding the most salient points to be kept under observation. The **Wing Commander** should, by a careful study of enemy positions, communications, etc., endeavor to form for himself, an estimate of what developments may have an important bearing upon the success of the attack, in order to make sure that these, if they occur, may be promptly reported by the balloon observers. An example may make this more clear. In the St. Mihiel attack, the town of Vigneulles, lying almost in the center of the salient, is the junction point of all roads leading to all sides of it. In the event of a German retreat, it was evident that practically all of his supplies and equipment would be withdrawn on trains passing through that town, and in addition his retiring troops must for the greater part, pass through there. If Vigneulles were successfully bombarded by artillery and bombardment planes, with a consequent interruption of road circulation, it was evident that in closing the pocket from Manhuelles to Pont-a-Houson, a great number of prisoners and a vast amount of stores would be captured. Naturally, the General Staff was most anxious to obtain any information concerning the road circulation through Vigneulles, and if balloon observers had been particularly cautioned to watch this town and the roads passing through it, they might have transmitted very valuable information—and possibly have contributed directly to the magnitude of the victory.

(b) After careful study of the map of the sector, conference with French officers, and after having thoroughly digested all information obtained, to select a number of balloon positions, to accommodate at least the number of balloon companies he has under his command, or can obtain if necessary. These positions should be marked so as to indicate whether they are good, fair, or poor.

(c) After a thorough estimate of the situation, taking into consideration all information available, and the study of the balloon positions, the Wing Commander should definitely determine

the number of balloon companies to be assigned to the sector. Consideration should, of course, be given the fact that some balloon companies may be required on other fronts, no matter how inactive the latter may be. A hasty or premature decision on this matter may prove very costly in the operation of the balloons.

(d) After the total number of balloons has been determined, the Wing Commander should determine the number to be assigned to each Corps, the number to be assigned to the Army Artillery, and the number to be held in reserve. This determination is made on the general estimate of the situation and from all information obtained.

(e) Either before or after he has made the determination under (d), the Wing Commander should make the final selection of his balloon positions. He should, from the total number, tentatively selected, select those which are most suitable, all things considered. This is, as a rule, done from the map, and immediately after this selection has been made, the positions and selections should be verified by a personal inspection. If considered advisable to make a change, this should be done and the change noted on the map. If time permits an inspection of all the balloon positions should be made, in order to make sure that the estimate made from the map was the correct one.

(f) The selection of the companies to be assigned to the new front should be then made, taking into consideration the general estimate of the situation and the relative training and experience of the Companies available. After the Companies have been selected they should be assigned to the different Corps, to the Army artillery, and to the reserve, according to their relative degree of efficiency, and to the mission which the Corps, and Army Artillery have to perform. The necessary transfer of officers in accordance with the above, should also be made

(g) The amount of gas available should be checked as soon as information is received of the contemplated attack and the sector on which it is to take place. If the supply does not seem to be sufficient, immediate steps should be taken to provide what may be considered as a very liberal allowance. After consultation with the officers of the French Balloon Service, and after careful study of the map of the sector, the gas depot (or depots) should be selected. Information concerning the exact location of this

depot (or depots) and the roads leading to it, should be sent to the Wing Commanders. As soon as information is received as to the approximate date of the attack (this can only be obtained in advance, in a general way) orders should be given for the shipment of the gas to the new depot (or depots) the Wing Commander should assure himself that the necessary amount of gas (according to his estimate) is at the depot (or depots) at least two days in advance of the date on which he believes or knows that the attack will be made.

(h) The Wing Commander should keep himself informed as to the state of reserve balloons and supplies and several days before the attack is to be made, he should personally inspect the stock at the balloon supply depot to assure himself that all material is on hand and in good condition.

(i) About one week prior to the date set for an attack, the movement of troops to the new sector will commence. As a rule Air Service units contemporary with other units. The Balloon Wing Commander must, therefore, be sure that his Companies have sufficient time to move to their new stations and establish telephone connections, camps, balloon beds, etc., before they are called upon to take part in the artillery preparation for the attack. About three days prior to that set for the attack the Chief of Air Service of the Army will call upon the Balloon Wing Commanders for a request for orders for the movement of the balloon units. The Wing Commander should, therefore, have prepared a memorandum showing the designation of the units to move, the sites to which they are to move, and the unit of the Army to which they are to be assigned. If time permits the Wing Commander should prepare for himself a table showing the units with which each Balloon Company may be supposed to work (Project de Reparation). A sample copy is attached.

(k) Numerous minor details, such as priority requests for road space, indicatives and wave lengths for wireless, are attended to when opportunity permits.

It is not to be inferred from the above that the Wing Commander leaves little or nothing to the judgment of his Group Commanders. Within their own sphere the latter are supreme so far as concerns balloon operations and should be held responsible for the most efficient disposition and operation of the Bal-

loon Companies under their command. As soon as the Balloon Companies are assigned to a Group, the Group Commander assumes entire jurisdiction over them and has full authority to make any changes which may be necessary or advisable.

GEIGER,
Lt. Col. Air Service, U. S A.

SAMPLE COPY OF PLAN OF EMPLOYMENT OF BALLOONS DURING AN ADVANCE.

Note: This plan was prepared by a Balloon Group Commander in command of the balloons in one of the Corps of the 1st Army, in preparation for the attack at St. Mihiel. It was sent for approval to the Wing Commander of the Army, after which it was disseminated to the Company Commanders, through the medium of verbal or written orders, and conferences

Balloon Group, 1st Corps—1st Army
Sept. 10, 1918.

Plan for Balloons.

1. **Assignment of Balloons.**

1st Company	1st Division
2nd Company	2nd Division
3rd Company	3rd Division
4th Company	1st Corps
5th Company	1st Army

2. **Location of Balloon Companies and Ascension Points.**

Balloon No. 1.

Chart Room	L.4320
Ascension Point	L.3741
Advance Point	L.3569

Balloon No. 2.

Chart Room	L.7056
Ascension Point	L.7056—7959
Advance Point	L.7271

Balloon No. 3

Chart Room	M.1436
Ascension Point	M.1050
Advance Point	M.1085

Balloon No. 4.

Chart Room	L.6450
Ascension Point	L.6351
Advance Point	L.6950

Balloon No. 5.

Chart Room	M.0641
Ascension Point	M.9948

3. Line of Advance.

Balloon No. 2 will advance:

(a) to Mandres, via Hanonville, to Beaumont, to Seichprey, to St. Baussant. or,

(b) direct to Mandres, Beaumont, Seichprey, to St. Baussant.

Balloon No. 4 will follow Balloon No. 3 and the two balloons will maintain proper intervals between advanced ascension points, chosen as circumstances dictate.

Balloon No. 3 will advance along the road to Ansauville, to Bernecourt, to Flirey, to Essey-et-Maiserais.

Balloon No. 5 (Army balloon) will advance along the same road as Balloon No. 3.

4. Liaison.

(a) Telephone Liaison.

1. Each balloon will have direct telephonic communication with the unit to which it is attached. In case of advance Balloon Companies will make every effort to effect direct communication with the unit to which attached but it should be understood by those units, (Div. Hqrts. and Art. units) that often the balloon cannot find the P. C. of the units and if a line is run from the P. C. of the winch (following the balloon which can be seen in ascension) much more effective and faster communication can be established.

2. Each balloon must determine what the next position of the advanced Artillery Information Service Central will be and establish direct communication with that central.

3. Each balloon must establish liaison with an artillery unit to which **direct** telephone communication must be established, for fire on fugitive targets—preferably with 155 mm. G. P. F.s, Divisional Balloons should also establish such liaison with the Corps Artillery. All balloons must be in personal liaison with the artillery units in their vicinity and discover the next probable position of the artillery battalion to which they have been attached for fugitive target work. If possible the artillery should run lines to the balloons. They can see the balloon and can run to the winch. The balloon cannot see them.

(b) Personal Liaison.

1. With Artillery Units.

The closest possible personal liaison must be kept up with the artillery in the vicinity of the balloon and especially with the unit to which attached for fire on fugitive targets.

2. With Divisional Staff.

Observers must seek out Divisional Headquarters and give them the benefit of any information they have obtained in the basket. Often, things that seem immaterial to the observer, are of importance to the Divisional Staff, and this can only be discovered by personal liaison.

3. With Aviation.

When transportation permits, personal liaison is made with aviation in order to get the benefit of their observations and to compare observations made during the day.

(c) Wireless Liaison.

Each balloon will maintain its wireless sending and receiving stations and will be equipped with a wireless wave length and a code call.

Note:—Each balloon will have direct communication with Corps Central, or through the next Balloon Company to Corps Central and from there to P. C. of Balloon Group, C. O.

SAMPLE OF TELEPHONE REPORTS FROM BALLOON GROUP HEADQUARTERS ON A DAY DURING WHICH AN OFFENSIVE OPERATION IS IN PROGRESS.

Note: These reports are made from the direct reports of the balloon observers, telephoned first to Group Headquarters, and from there to Wing Headquarters.

1st Corps.

6:25 A. M. 3rd Balloon near Ansauville, up all night.
3rd, 1st and 2nd Balloons up at 6:10 A. M.

2nd Corps.

6:25 A. M. 1st and 5th Balloons up at 6:15 A. M.

2nd Corps.

7:30 A. M. Report St. Braussant and Margereas taken. Everything progressing.

Army Balloon.

7:30 A. M. B-41 (41st Company) 300 meters. No visibility to the line. No action on our rear lines.

1st Corps.

7:50 A. M. Nothing to report.

5th Corps.

7:50 A. M. Nothing to report.

3rd Corps.

8:00 A. M. Observer reports action of enemy very feeble. Balloon brought to ground account high wind. Observer reports, "Have not seen any bombardment of our rear lines." (This last probably in reply to request for information on that matter.)

Army Balloon.

Jouey les Cotes (location of balloon)

9:45 A. M. B-41 Our troops are in intermediary positions.

3rd Corps.

10:15 A. M. 1st Co. Line extends to H-8, X-1, Y-0 (coordinates of limiting points). Reports not confirmed (this from Gr. Com. 3rd Corps). Troops at H-0, R-5 on road Monsec to Riechecourt.

10:15 A. M. 2nd Co. Reports received at 9:15 A. M. from liaison officer at D-1, 39. Observatory at Lionville reports combat in direction of Pannes, Essey, and Marzeraes have been taken by Americans.

1st Corps.

11:27 A. M. 5th Co. (Ansauville) Lt. Boyd fell from basket, leg broken and back sprained. All our balloons and Boche balloons down account high wind.

4th Corps.

11:40 A. M. Balloon Group B. Cable of B-1 broke at 7:15 A. M. Last seen, approximately 10,000 feet. Balloon going E. Lts. Tait and Hindeman in basket; neither jumped.
Les Esparges taken at 8:30. Little visibility; balloons down account high wind.

3rd Corps.

9:06 A. M. (Bricourt) B-1. Our advanced elements are in Bois de Madine. Friendly Bengal fire lighted in direction hill 237.8 (road Monsec-Richecourt).

9:30 A. M. Pannes taken.

9:39 A. M. Americans in Bois de Brierly apparently waiting for pre-arranged objective.

14:00 (2:00 P. M.) Balloon 3. (communicated by artillery) Line passed by Nonsard, Monsec, Loupment.

1st Corps.

15:15 (3:15 P. M.) Report of accident to Lt. Boyd coming in. Owing to high winds balloon blown against tree and punctured. New balloon inflated and ready for ascent. Tubes sent to station for refilling.

2nd Corps.

15:30 5th Co. Balloon not able to function account high winds. Nothing new. Change in line of balloon will come through message center.

1st Corps.

19:25 B-2 leaving present position for a point at St. Baussant.
B-1 has moved to Richecourt.
B-4 has moved to Bois de Gury.
B-3 has moved N. of Fliery.
B-5 has not moved as yet.
B-2 and B-5 tore hole in fabric, losing gas. Caused by the high wind while being brought down.
B-2 and 5 are out of gas. No supply.

1st Corps.

20:15 B-2 operating tonight in new position.
B-5 will move in the morning to Bois de la Hazelle.

3rd Corps.

11:10 P. M. B-3 moves from Jouy to Gironville. Ascension from 4:30 to 8:00. Lt. La Vrille, observer, reports intense bombardment E. of Monsec and from Aprement to St. Mihiel. At 7:30 balloon seen drifting S. E. At 7:45 a Spad monoplane coming from W. fires incendiary bullets toward balloon, and disappears, in the N. W. At 8:00 balloon hauled down.

4th Corps.

20:40 Balloon Group. Tonight 6th Bal. Co. moved to position W. of Mouilly, rest of Cos. will stand pat. Div. captured over 1000 prisoners and, at 4 o'clock were at Vaux and St. St. Remy and still going. Weather condtions look favorable for tomorrow.

4th Corps.

Balloon Wing. The 8th Balloon Company has moved from its station 2 kilo. N. E. of Dieue to position 1 kilo. S. of Commedieue.

3rd Corps.

22.25. B-4 moves N. of Thillombois-Troyon-sur-Meuse.
B-2 moves north of Petite Handres.

2nd Corps.

22.25. B-2 moves to Mamey. Bal. Gr. Hqrts. reports Jaulney balloon (German) burned, sometime late this morning.

DAILY REPORT OF OPERATIONS OF BALLOONS, 1ST ARMY.

From September 12 to September 13.

SAMPLE OF DAILY REPORT FROM:

Balloon Wing Commander, to Operation, C. A. S., Information, C. A. S., Chief of Staff, Air Service, File. eo

1. Balloon Group, 1st Army Corps.

Companies—1st, 2nd, 3rd, 4th, 5th.

Noon to noon, September 12-13.

Ascensions:

1st Co. 5:50-9:22. Observer, Lieut. A.; altitude 300m.; visibility 8-9 kilos.

2nd Co. No ascensions. Moved to forward position.

3rd Co. 4:40-8:25. Observers, Lieuts. B. and C.; altitude, 700m.; visibility, 8 kilos; wind, 20 meters.

4th Co. 9:51-10:08. Test flight; altitude, 300m.

Observations.

1. Enemy infantry—Nil.
2. Enemy artillery—Nil.
3. Enemy air service, Reported by

6:55-8:45.	Goin balloon in ascension.	B-5
7:27-8:45.	Filney balloon in ascension.	B-5
11:00-11:05.	Pilney balloon in ascension.	B-5

7:31-8:45. Grange en Haye balloon in ascension. B-5

8:09. Marieulles balloon burned at 81.2—46.0 by plane 21, 1st Pursuit.

7:00-9:00 Two planes seen in N. W. over enemy territory. B-5

7:00. Plane apparently descended in wood N. of Montauville. B-5

4. Circulation on roads, and railroads—Nil.

5. Destruction, explosives, fires, etc.

6:51. Large caliber shells in trenches 200m. N. of Norroy. B-5

7:07. Much smoke, apparently from heavy shelling at 70.0-37.5. B-5

7:12. Large caliber shells in Cheminot. B-5

7:20. Bengal flare at 75.45-38.80. B-5

6. Trench work, shelters, etc.—Nil.

Adjustments of artillery—Nil.

2. **Balloon Group, 2nd Army Corps.**

Companies—6th, 7th, 8th, 9th, 10th, 11th.

From 19:00 o'clock to 19:00 o'clock.

Ascensions.

6th Co. 6:50-8:22. Observer, Lieut. D.; altitude, 350-200m.; visibility, very poor.

7th Co. 6:41-7:49. Observers, Lieuts. E. and F.; altitude, 200m.; visibility, very poor; low clouds; tension, 550.

8th Co. 18:55-19:10. Observers, Lieuts. G. and H.; altitude, 540-400m.; visibility, very poor; tension, 400.

9th Co. No ascensions.

10th Co. 7:06-7:26. Observers, Lieuts. I and J.; altitude, 450-350m.; visibility, very poor; tension, 600. At 7:15 ordered to haul down. At 7:26 balloon broke cable at winch, ascended very rapidly, nose in air, headed toward enemy lines; observers stayed in basket.

11th Co. 6:25-7:00. Lieuts. K. and L.; altitude, 350m.; visibility, very poor.

Observations.

Nothing to report.

No report received from Balloon Group, 3rd Army Corps.

(Signed) ——————————,

SAMPLE OF A BALLOON OPERATIONS REPORT OF THE BALLOON GROUP OF AN ARMY CORPS, DURING AN ATTACK.

Note: This report is rendered daily by the Group Commander of the balloons in a Corps, to the Wing Commander. It covers the balloon operations of the day in that Corps.

1. On morning of attack, one balloon (3rd) was in ascencion and during previous night. The 2nd and 1st (Divisional Balloons) went up at day break, the 4th, about 8:30 A. M.

2. Balloons sent in some information but were badly handicapped on account of poor visibility and high winds.

3. Balloon No. 5 suffered an accident at about 10:00 A. M. Lieut. Boyd, observer; fractured leg and sprained back, due to anxiety of company to be in ascension. They tried to go up and wind caught them. Explanation in report sent to your headquarters.

4. Balloon No. 4 was ripped due to high winds.

5. Balloon No. 5 had one adjustment.

6. All balloons ready to move in P. M. of September 12 (day of attack.) Balloon No. 1 and Balloon No. 2 moved, A. M., September 13. Poor visibility and high wind on September 13, prevented ascension.

7. Group Commander was along line of companies this morning, but owing to crowded condition of road was not able to go past Beaumont. Hope to have better facilities tomorrow.

8. A. I. S. moves tonight and think telephone communications will be O. K. for information and adjustment tomorrow. The roads may be still too bad for movement.

9. Likely balloons can move no further until conditions become better for transportation.

10. All information possible is being sent to your office.

11. The positions of the balloons on September 13 is as follows:

- B-1 St. Baussant (Muerthe-et-Moselle.)
- B-2 Xivray-Harvoisin.
- B-3 Bois-de-la-Hazelle (1 kilo S. W. of Flirey.)
- B-4 Near Flirey (2 kilos N.)
- B-5 Bois-de-la-Hazelle (road between Beaumont and Flirey)

SAMPLE OF THE PORTION OF A PLAN FOR AN ATTACK WHICH RELATES TO THE BALLOON SERVICE.

Note: This is an extract from the plan for an attack prepared by the General Staff of an Army Corps in the form of a Battle Order. It refers to the St. Mihiel attack.

Extract.

(4) Balloons.

The balloons assigned to the Division and Corps will watch the operation and control artillery fire.

(f) One balloon will be on duty during the night, this duty being divided between the four balloons.

(g) Liaison.

There will be one direct telephone line from the P. C. of the Corps to the Observation Group. The C. A. S. will establish himself at the P. C. of the Corps.

Each balloon will be connected by direct telephone line with the artillery with which it is working.

(i) Routes for Advanced Balloon Positions.

1st Balloon Company—Hanonville - Mandies - Beaumont-Seichprey-St. Baussant.

2nd Balloon Company—To Raulecourt-Broussy-Bournville-Xivray-Richecourt-Lahayville.

3rd Balloon Company—to Ansauville - Grosrouvres - Bernicourt-Flirey.

4th Balloon Company—To Mandres-Beaumont-Seichprey-St. Baussant.

(j) Routes for Balloons in Case of Retreat.

1st Balloon Company—To Boucq-Trondes.

2nd Balloon Company—To Boucq-Trondes.

3rd Balloon Company—To Menil-le-Tour-Bouvron.

4th Balloon Company—To Boucq-Lagney.

BALLOON NOTES, A. E. F. NO. 52.

AMERICAN EXPEDITIONARY FORCES
OFFICE OF CHIEF OF AIR SERVICE
BALLOON SECTION.

The following instructions regarding **preparation of technical reports issued by the Group Commander** to Balloon Companies of the 5th A. C. will be found of value to other Group and Company Commanders.

By authority of C. A. S.

C. DeF. CHANDLER,
Colonel A. S.

HEADQUARTERS BALLOON WING
FIFTH ARMY CORPS
A. E. F.

7th September, 1918.

MEMORANDUM FOR: Balloon Companies, Fifth A. C.

1. Reports from the individual companies operating with the Fifth Army Corps are assembled and consolidated in this office, and the information contained therein is transmitted through this office to Corps and Army Headquarters, where the information furnished is compared and correlated with that gathered from other sources. It is evident then that what we report should be accurate and should be forwaarded with the least possible delay.

There are four main divisions of our routine report, as follows:

A. Observations.
B. Enemy Batteries Spotted.
C. Adjustments of Artillery.
D. Ascensions (Operations.)

The first of these is subdivided into eight headings, which are shown on the diagram attached hereto. The last includes ascensions of American and Enemy Balloons. These items are all well taken care of in the forms provided for the Daily Report. However, there are many times when it is essential that reports be made by telephone, and in order to facilitate handling telephone reports and to avoid delays and mistakes that seem likely to occur in such cases, it is suggested that the companies word their reports as outlined in the following diagrams.

FORM OF THE CONSOLIDATED DAILY REPORT ISSUED BY WING HEADQUARTERS.

GENERAL IMPRESSION OF THE DAY: (Increased, decreased or normal activity.)

A. Observations:

1. Enemy Infantry—Activity of.

2. Enemy Artillery—Activity of—Time of fire, what batteries are firing, objective, result of fire, as follows: Time, battery, caliber of shell, objective, result or time, number of shells falling, on what point, result.

3. Enemy Airplanes—Time, type of plane if identified, point at which seen (locate with reference to a fixed point such as a town, or give the co-ordinates of the point at which plane crosses lines), direction of flight, any unusual action, time of return across lines, mission if ascertainable.

4. Circulation—Enemy Roads—Trucks, cannons, or persons on foot. Time, number of vehicles or persons, location of road with reference to two towns, direction of travel (toward what town.) If vehicles or pedestrians quit the road at any point between the two towns mentioned the point at which they leave the main road should be located by co-ordinates.

5. Circulation—Enemy Railroads—Time, mainline or narrow-gauge, number of cars, between what points (towns), direction of travel (toward what town.) If the train is stopped at any point between the two towns named or branches off on to what seems to be a new line, this point should be located by co-ordinates.

6. Destruction, Explosions, Fires—Time, location, nature and cause of explosion or fire, extent of damage. Applies to both enemy and allied territory.

7. Trench Work, Shelters, Etc.—Of the Enemy—Time at which noted, place, nature and extent of the work. Includes camouflaging of roads; artillery positions, etc.

Miscellaneous—Items not covered in any of the above.

(Note: Smoke from a train is an item under A5. Smoke from a bivouac or cantonment under A8. Smoke from an explosion or destructive fire under A6.)

B. ENEMY BATTERIES SPOTTED.
(Sheet II of the Daily Report.)

C. ADJUSTMENT OF ARTILLERY.
(Sheet III of the Daily Report.)

D. ASCENSIONS.
American (Sheet IV of the Daily Report.)
Enemy (Report of Enemy Balloons—graph.)

Remarks:

At this time our reports cover the twenty-four hour period from 12:00 o'clock noon to 12:00 o'clock noon.

It must be understood, however, that the time of rendering these reports and the period covered may be changed at any time, and that telephone reports may be called for at any time, so that Chart Room Clerks must be prepared at all times to furnish complete reports of operations and observations.

Particular attention must be paid in this sector to rendering reports by telephone. They must be brief and accurate. To this end a standard form of report is necessary, and the following routine will be used by all companies.

When calling this office to make a report ask for "Chart Room." This will be understood as a signal that you have a report to make. When you are answered "Ready," use your company code name and proceed as follows:

In Reporting Observations:

"SMITH reporting Observation. Eleven twenty two, mainline, one train twenty cars, CHAMBLEY-MARS la Tour, towaard MARS la Tour."

In Reporting Enemy Balloons:

"SMITH reporting DRACHEN. VIEWVILLE up nine forty three, six hundred meters, on ground ten nineteen, up twenty five, five hundred meters, up ten thirty seven, six hundred meters, down eleven ten, four hundred meters, on ground eleven fifty."

In Reporting Ascensions of Your Own Balloon:

"SMITH reporting operations; up thirteen zero five, ADAMS and BAKER, eight hundred meters, visibility fifteen kilometers, on ground fourteen forty two."

Be careful to use your company code name when referring to

your own company or to your own balloon, and use code names for other balloons of the 5th Corps, when referring to them. DO NOT REFER TO ANY COMPANY BY NUMBER.

THESE INSTRUCTIONS ARE TO BE KEPT ON FILE IN THE COMPANY CHART ROOM.

By order of Major Jouett.

CARLETON C. JONES,
First Lieut., Air Service, Adjutant.

Company Chart Room Records.

All companies will make up the following forms and keep them up to date, checking off the items as they are reported to headquarters, but keeping the information on file as a permanent record for a later use.

A-3—ENEMY AIRPLANES

Date	Hour	Number Planes	Type	Location	Direction of Flight	Time Returned	Remarks (Mission)

A-4—CIRCULATION—ENEMY ROADS.

Date	Hour	Number of Pedes-trians	Number of Vehicles	Between	Toward	Remarks

A-5—CIRCULATION—ENEMY RAILROADS

Date	Hour	ML or NG	Number of Trains	Number of Cars	Between	Toward	Remarks

NOTES ON THE DUTIES OF THE GROUP COMMANDER.

The following notes will illustrate the instructions which should be given the officers in command of the Balloon Companies in a Balloon Group, by the Balloon Commander. The notes were made during the **preparation for the attack at Verdun by the 1st U. S. Army,** and during the attack itself.

Duties of Group Commander.

1. After the Balloon Companies of a Balloon Group have been in their new locations, or in other words, have arrived at the positions assigned to them in the sector where the attack is to be made, there should be several (possibly three or four) days during which the preparation of the balloons for the attack and advance, should be completed. The Group Commander should untilize this period to assure himself that his Company Commanders have been fully instructed in their various duties and that the orders he may have given for the attack are being carried out.

Assignment of Companies.

The first detail to be settled is the definite artillery assignment of each company. In order to do this the Group Commander, under instructions from and with the approval of the Wing Commander, designates the companies to operate with the Divisional Artillery, and the company to operate with the Corps Artillery. If, in his judgment, it is advisable, he also may designate one or more companies to be held in reserve. He indicates to each Divisional Balloon Company what Division it is to work with. After this assignment has been made, a study is made of the disposition of the artillery in the Corps, and a Group, or sub-Group (called a "Groupment") is assigned to each balloon company. In making this assignment the following points should be considered:

1. The caliber of the pieces in the Group or Groupment.
2. The proximity of the Group or Groupment, to the balloon position.
3. The attitude of the officer commanding the Group or Groupment toward reglage by means of balloon observation.

It has been found that the range and objectives of the 155mm. guns (either short or long) and the 9.2 howitzers, render these

two pieces particularly in need of relage by balloon observation. An effort should therefore be made to assign the balloons to Groups or Groupments, which are composed of either 155mm. short, 155mm. long, or 9.2 howitzers.

In addition, it is more or less essential that the Group or Groupment be in reasonably close proximity to the position of the balloon telephone central. This will avoid the labor and difficulties involved in the laying of great lengths of wire and will, in addition, facilitate the work of liaison with the Group or Groupment in forward positions, inasmuch as the balloon will, as a rule, be able to move forward along the route taken by the artillery.

The attitude of the officer commanding the Group or Groupment, toward balloon observation, has also a decided influence upon the assignment of the company to that Group or Groupment. In some cases it will be found that the artillery commander will not care to utilize the balloon as an instrument of reglage, except when all other means have failed. He may feel that he can usually obtain better results from his terrestrial observation posts or from airplane observation. In such cases the greater part of the time during which the balloon is in ascension will be devoted simply to general sector observation and its main role, that of artillery reglage—will be almost lost. On the other hand, there may be artillery commanders in the Division to which the balloons are attached, who have great confidence in the work of the balloons. In general, it will be advisable to so arrange that the balloons work with one or more of these commanders, even at the expense of considerable labor in constructing telephone lines. Due consideration should, of course, be given the objective or objectives of any Group or Groupment, to which it is contemplated assigning a balloon. If most of the terrain in which these objectives lie, is defiladed from the balloon, it would be useless to attempt to work with that Group or Groupment, at least until its objective is changed, or until the ascension point of the balloon is changed.

2. When an attack is contemplated on a particular line of the front, the artillery is massed in rear of this line and is divided into three main divisions:

(a) Army Artillery.
(b) Army Corps Artillery.
(c) Divisional Artillery.

Each of these main divisions is under the command of a

General Officer (Brigadier General.) In addition, the Army Artillery, Corps Artillery, and in some cases the Divisional Artillery, is sub-divided into Groups, each of which is under the command of a Colonel. Each Group is sub-divided into Groupments, generally under the command of a Lieutenant Colonel or a Major.

The balloons which work with the Army Artillery are each assigned to a Group of this artillery and after such assignment generally are attached to a particular Groupment of this Group for reglage. The Groupment to which the balloon is attached should, by reason of its caliber and location, be best fitted to work with the balloon. The same procedure is followed in the assignment of the balloon, which works with the Corps Artillery, and to the balloons which work with the Divisional Artillery, provided the latter consists of more than one Group. In case the Divisional Artillery consists of but one Group, the Divisional balloon is assigned to one or more Groupments within this Group.

P. C. of Groupments.

In any case this assignment is made by the Balloon Group Commander, with the approval of the Balloon Wing Commander. After having so assigned his balloons, the Balloon Group Commanders are fully informed as to what unit of the artillery of the army they are assigned (whether Divisional, Corps, or possibly Army), what Groups they are assigned to and what particular Groupment or Groupments they will work with. They should also be informed of the name of the officer commanding the Group and the name or names of the officer or officers commanding the Groupment or Groupments, with which they are to work. In addition, if the Balloon Group Commander has the information, he should advise his Company Commanders as to the location of the P. C. (post of command) of the Artillery Group Commander, and the P. C.'s of the Groupments with which they are to work. At the P. C. is generally located the telephone central which connects to all batteries of a Groupment or to all the Groupment P. C.'s in a Group. The P. C. is generally designated by the name of the officer commanding the Group or Groupment, as the case may be. For example: P. C. Scott would designate the post of command or Headquarters of the Artillery Group commanded by Colonel Scott. At this point a telephone central is installed which connects to the centrals at the P. C. of each Groupment within this Group. A line will run, for example, to P. C. Smith,

which is the post of command or Headquarters of the Groupment commanded by Major (or Lieut.-Col.) Smith.

In case the Balloon Group Commander does not know the location of the several P. C.'s to which his balloon companies must connect, it becomes the duty of each Company Commander to ascertain as soon as possible the P. C.'s with which he is concerned. He should first locate the P. C. of his Group Commander and from this point should determine the P. C.'s of the Groupments. As soon as the P. C. of the Group Commander has been located, the Balloon Company Commander should visit this post and confer with the Group Commander or his representative. He (the Balloon Company Commander) should state his particular assignment in the Group, and should request instructions as to whether the Group Commander may desire that this be done. The Balloon Company Commander should, if requested, inform the Group Commander of the ascension point of the balloon, defiladed areas, and, in general, the work which the balloon is prepared to do. He should endeavor to carry out any instructions or requests relating to reglage with balloons, which the Group Commander may give him.

After visiting the P. C. of the Group Commander, each Balloon Company Commander should visit the P. C. of each Groupment with which he is to work, and give all necessary information concerning the work which the balloon can do. In particular he should inform the Groupment Commander of the areas which are defiladed from the balloon and the objectives which it can see. He should ascertain the exact location of the telephone central and should inquire of the Groupment Commander whether or not a direct line from the balloon to any particular battery or batteries, is desired.

After he has completed his visits to the Group or Groupment P. C.'s, each Balloon Company Commander should draw up his diagram of telephone connections. This diagram should show all regular lines (such as lines to rear centrals, Balloon Group Hqts., Hqts. Div. Art., etc.) and, in addition, such special lines as are necessary for efficient reglage (such as lines to P. C., Group Commander, P. C. Groupment, direct lines to batteries, etc.) These charts on completion, are immediately sent to the Balloon Group Commander, who consolidates them in the form of a single chart which shows all telephone connections in the Group. (A copy of such chart is being forwarded.) The Balloon Group

Commander sends his chart to the Wing Commander, who prepares a single chart which shows all balloon telephone connections in the army.

Telephone Connection.

It is the duty of the Balloon Group Commander to be certain that the telephone connections are made and are in order, at least one day prior to that set for the attack.

In working out the assignments of balloons to Groups or Groupments, and the necessary system of telephone connections within the Corps, there are two maps prepared by the Intelligence Section of the General Staff of the Corps (called G-2) which will give most valuable information and which should be thoroughly studied, both by the Balloon Group Commander and by each Company Commander These groups are known as:

(a) Map of Artillery Positions, and
(b) Map of Artillery Objectives.

The first shows on a 1/20,000 scale, the areas of artillery positions, indicating by a suitable legend, the Groups, Groupments and calibers. The second shows on the same scale, the areas where are located, the objectives of, the Army Artillery, the Corps Artillery, and the Divisional Artillery. It also shows the sector assigned the Corps and the divisions of this sector, which are assigned to each Division of the Corps, for the advance. The axis of liaison for the Corps and for each Division thereof, are indicated. (Copies of maps prepared by G-2 5th Corps for the Verdun attack, are being forwarded.)

Maps.

A study of these maps will serve to indicate how much information of value to the balloon commander is contained therein. Each Balloon Company Commander should be required to prepare for himself a copy of each map to show the situation as concerns his balloon. In other words, from the map of artillery positions he should copy the areas on which the Group, with which he is to work, is located, and from the map of artillery objectives he should trace the Corps sector, the sector of his Division (in case his balloon is assigned to a Division) the axes of liaison of the Corps and of the Division (for Divisional balloons.) He should also trace off the area of artillery objectives assigned to the

Division with which he is working, or Corps artillery objectives in case his balloon is assigned to the Corps Artillery.

From the information which he can thus obtain, the Balloon Company Commander will know the direction of advance of the Division or Corps with which he is working and will not get separated from it. He will understand on what roads the artillery is to move forward and, in addition, will be familiar with the location of all artillery objectives assigned to his Division or Corps. From the positions of the artillery Group or Groupment to which he is attached he will know in just what areas are located the batteries of his Division or Corps and of what guns or howitzers these batteries consist. As may be seen, all of this information will serve to give the balloon officer a comprehensive knowledge of the artillery situation as concerns his balloon and should result in his mapping out a course of procedure on an intelligent basis.

The plan of employment of artillery, prepared by the Artillery Commander of the Corps, will also furnish valuable information, particularly as to the various groupings of artillery, caliber, assignment to Division or Corps, regiments, officers commanding units, etc. This plan has much information in addition, which while of considerable interest, will not be of particular value to the balloon observer. It, however, does prescribe the number of rounds allotted to each caliber of gun-information which, in many cases, may be of value to the balloon officer. The plan of artillery employment should at least, be entirely read by each Company Commander, and all information of value extracted.

After the above information has been transmitted to all Balloon Company Commanders, the Balloon Group Commander should require at least one day prior to that set for the attack, a "defilade" map of the sector of the balloon. These maps are generally made on a 1/22,000 scale Plan Directeur, and show the areas in the sector of observation of the balloon which cannot be seen at the usual altitude for observation. These areas are generally plotted for three altitudes, viz: 800m., 1,000m., and 1,200m. They are plotted in the usual manner by dividing the balloon sector into smaller sectors by means of radial lines, and then dropping profiles of these radial lines. Between profiles the defilade areas are generally interpolated. After receipt at Balloon Group Headquarters, these defilade maps are consolidated into a single map which may show either the areas defiladed from all balloons in the Group at 1,000m., or if time does not permit,

the maximum area, which is under defilade, viz: the area which will be defiladed from at least one balloon of the Group.

Defilade maps are also furnished by the Balloon Company Commanders to the Chief of Air Service of the Corps, who can determine from them what areas can be seen by balloons and what areas must be taken under observation by the planes of his observation group, both for artillery reglage and for general sector observation. In addition the Balloon Company Commander furnishes the officer commanding the Group or Groupment with a defilade map if so desired. Generally, however, this matter is gone over in conference, the artillery commander taking from the balloon officer's map, the defiladed areas pertaining to the particular sector in which his objectives lie. The importance of a carefully prepared defilade map is, of course, evident, for without the information therein contained, the balloon might be allotted a target in an inaccessible area, and it might be too late to change to another form of observation after the mistake has been discovered.

The Balloon Group Commander should also caution the Company Commanders to get in touch with that battery or batteries in their Group, which are especially assigned to the destruction of fugitive targets. They are, as a rule, the 155 mm. long guns, although guns of greater or less caliber may sometimes be used. If this fugitive target Groupment has not been definitely assigned to the balloons, a direct line should be run to that P. C. and the details of balloon observation should be gone over thoroughly in conference between the Balloon Company Commander and the Groupment Commander. In particular should the defilade areas be given a most careful study.

Gas.

3. In the preparation for an attack the problem of gas supply is a very important one and should be given the greatest attention. In an advance the expenditure of gas will be proportionally very high. If a balloon cannot move forward inflated, it must be deflated and again inflated at the new ascension point. Due consideration must be given to the fact that in periods of great activity, enemy aircraft will be active and many balloons may be burnt. Numerous other causes will also tend to increase the supply of gas necessary to keep the balloons properly inflated. The Group Commander must, therefore, take such steps as will

insure each company having at its disposal a sufficient supply of tubes to permit it to keep its balloon inflated during the entire period of the advance, and possibly for some days thereafter. To arrange this detail the Group Commander must first estimate the number of tubes necessary, with a sufficient surplus as a factor of safety. He should then present this estimate to the Wing Commander and request that his balloons be allowed to draw at least that number of tubes from the gas supply depot. Enough tubes should be provided by the Wing Commander to fill the requirements of all balloons under his command as estimated, in the total of the estimates of the several Group Commanders. The initial allowance to be drawn, is generally fixed by the Wing Commander and will depend upon whether or not the balloons are to be inflated during the preparation for the advance. In the Verdun attack, in order to prevent the Germans learning the fact that American troops were occupying the front, but one balloon was inflated until the night before the attack was made. As a rule each company should draw, as its initial allowance, 200 tubes, if not inflated. It requires about 160 for the initial inflation, leaving forty as a reserve, to be carried with the company as it moves forward. It generally requires about four tubes per day for "topping up." (The French tube used in the Verdun attack is slightly larger than the American tube.) Empty tubes, as soon as emptied, are sent back to the gas supply depot or other depot designated by the Wing Commander. In case a re-inflation becomes necessary, arrangements must be made for the supply from the depot being brought up in the minimum time. This requires prompt action on the part of every one concerned and every obstacle which may cause delay, should be removed so far as is possible.

All Company Commanders should be informed as to the number of tubes to be drawn on their initial allowance, and they should be given specific information as to the location of the gas supply depot and the most direct route to it. During the advance it may be possible to establish a forward gas depot and if such be done, all Company Commanders should be informed, without delay, of the location of this depot and of the most accessible route to it from their advanced position.

4. In the preparation for the attack, the Group Commander should make sure that there is a sufficient amount of telephone wire on hand in each company. The latter should have at least 60-80 kilometers at the time that the attack starts. If any com-

pany happens to be short, a requisition should be made without delay and immediate steps should be taken to obtain the amount necessary. In many cases it may be possible for a company to salvage wire which has been laid in preparation for a former attack and which has no further use. In an advance much wire can also be salvaged in the sectors occupied during the advance. In the Verdun advance the supply of telephone wire was rather limited and Company Commanders were instructed to salvage as much as possible without any delay in their forward movement and without disturbing wires which were serving a useful purpose. They were also cautioned to take such steps as would prevent the loss of their wire through the mistaken zeal of some other organization which desired telephone wire for its own use.

Secret Movements.

5. In the preparation for the attack on the Verdun sector, great secrecy was demanded in order that the enemy might not learn of the departure of the French Army, which had held that sector, and of the arrival of an American Army on that front. During the occupation by the French, there was but one balloon in operation. This balloon was replaced in its position, by an American balloon and as soon as the latter was established it was inflated and put in ascension. A French cocard replaced the American cocard, in order to lead the enemy to believe that the French company was still occupying the position. As no other French balloons had been operating within the sector occupied by the 5th Corps, no more American balloons were inflated until two nights before the attack was made. As soon as inflated the balloons were carefully concealed and did not ascend until daybreak of the day of the attack. However, in order that all observers should have an opportunity to familiarize themselves with the sector, advantage was taken of the fact that one balloon was in ascension, and as many observers as conditions permitted were sent up with this balloon from the time it was put in operation.

The artillery preparation started three hours before the time set for the infantry attack (5:30 A. M.) and at that time, which was about daybreak, all balloons were to go up for artillery reglage. The balloons of the 5th Corps were all in ascension at daybreak ready for artillery observation. The visibility, however, would not permit of any observation beyond approximately four kilometers, and, as a consequence, **artillery reglage was impossible** until later in the day. This was most unfortunate as, in an advance,

the artillery will always move forward as soon as their objective has been destroyed or as soon as a new objective has been assigned at a greater distance in rear of the enemy lines. Therefore, as soon as a fair visibility prevailed the balloons were used to considerable value in obtaining information as to the development of the attack. In order to facilitate this all **Company Commanders were instructed** to move their balloons forward as far as possible and **to follow the advance of the infantry.** In the 5th Corps the Group Commander had **installed a forward central** from which direct lines were laid to **all the balloons of his Group.** In addition, from this forward central a direct line was laid to G-2-C (Intelligence Section of the Corps General Staff.) Through the latter, connection could be made to almost any other office in the Army. All Balloon Company Commanders were instructed to telephone immediately to the forward central all reports on movements and developments at the front, and in the rear of the enemy lines. Reports, as they came in, were forwarded by means of the direct line, to G-2-C, and in this way much valuable information was furnished. Some artillery reglage was accomplished but, as stated above, there was very poor visibility in the morning and in the afternoon most of the Artillery Groups with which the balloons were working, were preparing to move forward and had broken telephone connections.

In the training of balloon observers, it might be well to inform them of this most discouraging feature of their work. On some days he may be able to devote the entire time to artillery reglage, or very useful sector surveillance, while on others there is nothing to do but sit in the basket and look out into a mist which prevents a view of even the front line trenches.

The first day of the attack opened with an entire air superiority on the part of the American and French planes. Practically no German planes were in evidence on the front. However, during the latter part of the day the enemy air service was undoubtedly reinforced to such an extent that German planes became extremely active and daring. Appearances seemed to indicate that an adequate protection for the balloons was lacking. As a result three American and one French balloon were burned within a very short period during the afternoon of the first day. This was in marked contrast to the situation in the St. Mihiel attack, where, in three days, but a total of three balloons were burned, while, on the other hand twenty-eight German balloons were

destroyed by Allied aircraft. In the St. Mihiel attack the American and French planes had almost complete air superiority throughout the entire period.

The destruction of the four balloons resulted in the loss of one observer. A German pilot, after having evidently climbed to a height beyond the observation of any ground or aerial lookout, shut off his motor and volplaned down in the rays of the sun to a position from which he could quickly dive down to a balloon beneath. He was, therefore, entirely invisible until just before he appeared directly over the balloon. There was no time to call upon the anti-aircraft batteries for a barrage, nor was there sufficient time to even attempt to haul down the balloon. The two observers were directed to immediately jump and one managed to get away in time to keep entirely clear of the burning balloon, during his descent. The second observer, who jumped after the first, was evidently held momentarily, by either his headset or his field glasses, or both. There was practically no wind and as this observer descended in his parachute, the burning balloon overtook him, burning the parachute. There seems little or no method of avoiding a similar occurrence in case a combination of circumstances, as occurred in this particular case, should be repeated. Even the best trained and most vigilant lookouts could not detect the approach of a hostile plane in the rays of the sun when the plane is volplaning with the motor silent. The most prompt work on the part of the Maneuvering Officer could not prevent the burning balloon from falling on a parachute directly beneath, when there is no time to move the balloon before the latter is set afire and when there is not sufficient wind to carry the parachute quickly off to one side.

As has been reported on previous occasions, the German aviator exhibited a poor degree of sportsmanship in opening a machine gun fire upon the first observer during his descent with the parachute.

During the next two or three days of the advance, the condition of the roads not only greatly interfered with the forward movement of both artillery and balloons, but also, in delaying the advance of communication troops, practically isolated the Balloon Companies from their artillery units and also from the Group and Wing Commanders. For at least two days, the Group Commander of the 5th Corps was almost out of touch with his balloons. Efforts to visit more than one Balloon Company proved

practically useless, as it required nearly twenty-four hours to make a visit to a single company. The poor weather was, in addition, a great factor in decreasing the activities of the balloons. Rain, mist, wind, or low clouds, prevailed during a great part of the time and little or no observations could be attempted, even where the artillery and balloon were ready to work. It was, nevertheless, urged upon all Company Commanders that they should make every effort to reach as forward a position as possible, even though some time might elapse before communication could be established. One company of the 5th Corps seemed very successful in reaching forward positions and this was no doubt due to the energy and judgment of the Company Commander and his Maneuvering Officer. This company got a very early start on the morning after the attack opened—about the time that the artillery and trains were ready to move forward in support of the infantry. In getting started before this train movement, the balloon of the company mentioned was able to make a considerable advance before the condition of the roads compelled a halt. The company then watched for a chance to get a place in the line of moving trains, and finally was able to gain a forward position where, with reasonably good visibility, the observers could undertake a thorough surveillance of the sector of the balloon and take on artillery reglage when the artillery were ready. The telephone communication to the rear was not such, however, as to permit of communication with the Group Commander for a considerable period of time and courier service required from twelve to sixteen hours.

It seems evident that if the conditions which prevailed on the advance are to be repeated—a very likely condition on a front similar to this one—**it will be necessary,** if the balloons are to be of real value, **for each Company Commander to use his own ingenuity and devise some method of bringing his balloon and winch to a forward position as soon as possible.** The method employed by the company referred to proved successful, and it seems certainly possible for an energetic and resourceful Company Commander to get forward if the artillery is going forward. If he does not get forward his balloon will be of little or no real value, inasmuch as one day after the infantry advance has started, the line will have moved so far ahead that further developments will be entirely out of range of the balloon. The problem of good communication is certainly a difficult one during the advance. As stated above **the Group Commander of the balloons in the 5th**

Corps for two days, had no communication with his balloons except by courier, and it took from twelve to sixteen hours for reports to reach him by this means. As a matter of fact the lack of prompt communication with the front lines was greatly felt by the General Staff of the Corps, and if an efficient system could have been established whereby reports from balloon observers were sent in, other than by courier, such reports would have proved the only regular channels of information to the rear. Such a situation only emphasizes the necessity for the establishment of some prompt and reliable method of communication between the balloon observer and G-2 or G-3 of the Corps (G-3 is the Operations Section of the Corps General Staff.) If the balloons can uniformly reach a forward position, advancing each day as the infantry advances, and if, in addition, some system of immediate communication can be provided whereby the General Staff may quickly receive the reports from the observers, it seems certain that the main reliance for information will rest upon the balloon service. It seems certainly possible that, where it becomes impossible to establish communication by telephone, the radio sets with which each company is provided, may be utilized to great advantage. It might be possible to obtain good results if each Group Commander were to provide himself with a radio set (sending and receiving) and install it in a forward position, together with his telephone switchboard. In the event that telephone communication is interrupted (as it seems certain it will be as soon as the balloon moves forward) reports from the balloon observers could be sent to the Group Commander by wireless and from his office, relayed to G-2 or G-3 by telephone. In the event that the Group Commander decides to move still further forward he need only extend his telephone lines so as to be in constant touch by telephone with the Headquarters of the Corps. It is possible that some such system as this may be attempted during the next prospective advance. Radio communication for Balloon Companies, while in the past, has not been considered of primary importance as compared to telephone communication, may possibly find a very important function in the future. The presence of well-trained radio operators and mechanics in each Balloon Company may, therefore, prove a material factor in its efficiency at the front. Radio equipment and personnel would, of course, be provided for Balloon Group Headquarters.

6. **During the first three days of the Verdun offensive a**

total of six balloons were burned by German planes. This seemed a rather high percentage of the total number of balloons on the line and it seems evident that unless there is ample protection for the balloon it is more or less at the mercy of hostile aircraft. The only adequate means of protection seem to be the anti-aircraft batteries in the vicinity and a sufficient number of pursuit planes in operation in the sector. Considerable reliance is, of course, placed up the early detection of the hostile plane and rapidly hauling the balloon down. However, experience in the St. Mihiel and Verdun offensives seem to indicate that unless Allied planes obtain a decided air superiority, a considerable number of Allied balloons will be destroyed, with the inevitable result that a state of nervous tension will prevail in the personnel of the companies on the line. This will lead to a situation where all balloons are in an almost constant state of being hauled down or let up and can never be able to perform their duty of artillery reglage or sector surveillance.

In this connection it may be stated that **the Germans** evidently have made a considerable study of the methods of removing defiladed areas from balloons and it has been found that their **balloons are so placed on the line that the area defiladed from one balloon will be visible from another in so far as it is possible to do so.** In this way practically all of the terrain in the rear of the Allied lines can be observed from German balloons. They apparently are also very careful to so place their balloons as to command the observation of large stretches of important roads, cross roads, etc. They can, therefore, get from their balloon observers, very valuable information as to the circulation on roads in rear of Allied lines.

GEIGER,
Lieut. Col. Air Service, U. S. A.

SELECTION OF BALLOON POSITIONS.

1. What is known as a "Balloon Position," consists of the following:

(a) Position and location of the balloon bed.
(b) Position of ascension point.
(c) Company camp site.
(d) Balloon itineraries, viz: routes to be followed in taking the balloon from its bed to the ascension point.
(e) Advance and retreat routes.

2. These are the essentials of any balloon position and should be carefully selected by the Company Commander, and afterwards approved by the Group Commander. In many cases the balloon positions will have been selected in advance either by the Group Commander or by the Wing Commander. This will be the case when the sector, to be occupied by the army with which the balloons are serving, has formerly been occupied by the French and the balloon positions have previously been established.

In an advance, of course, where the balloon position changes each day, the duty of selecting the new balloon positions naturally talls upon the Company Commanders, following general instructions given by the Group Commander.

3. By "Balloon Itinerary" is meant the route which should be taken in moving the balloon from the bed to the point of ascension. This route must afford a good passage for the balloon and be free from obstacles which would prevent the movement of the balloon. Such obstacles as overhead wires and branches of trees extending over the road might entirely prevent the passage of the balloon. In many cases, however, such obstacles could be removed or avoided. An inspection of the proposed itinerary by the Company Commander or Maneuvering Officer, will determine whether or not the route can be made clear for the passage of the balloon. In many cases, however, such obstacles could be removed or avoided. An inspection of the proposed itinerary by the Company Commander or Maneuvering Officer, will determine whether or not the route can be made clear for the passage of the balloon. On an advance the itinerary is very often reduced to zero, the balloon and ascension point being at the same place.

4. The points to be observed in the selection of balloon bed locations, itineraries, ascension points, advance routes, etc., as well as the precautions to be taken in their selection, are described in a report from the Maneuvering Officer of the 6th Balloon Company. This report is now being made up as a Balloon Note, A. E. F., and a copy of the same will be forwarded to the Balloon Branch, Training Section, D. M. A., Washington, D. C.

GEIGER,
Lieut. Col. Air Service, U. S. A.

REPORT FROM THE COMMANDING OFFICER OF THE FIRST ARMY AEROSTATION, ON THE OPERATIONS OF AUGUST, 1918.

GENERAL CONDITIONS.

Surprise attack after short preparation of artillery; at first this attack is carried out by the two British Army Corps, which are placed immediately to the North, and then it spreads out successively to the four Army Corps that are in the line on the front of the 1st Army.

On August 8th, the starting line is, in a general way, situated immediately to the west of the Avre (on certain points, our infantry had reached the valley in course of advances which preceded the attack.) To the north, the progression begins region south of the Luce.

The success of the attack was to be followed by an immediate pursuit in the general direction of ROYE.

For the balloons, the operation appeared as follows:

A first operation corresponding with the beginning of the attack.

A rapid progression in close touch with the infantry.

PREPARATION AND GENERAL INSTRUCTIONS.

The following instructions were given:

(For the beginning of the day J):

Progression will be carried out at the same time as that of the troops:

The forward movement of the balloons should be foreseen and prepared.

This preparation has been proceeded as follows:

1°—By reconnaissances as far as the first lines.

2°—By studies of photographs for the zone beyond.

3°—Through communication with the Commanding Officers of Map Companies giving itineraries of ascent and of transportation used by the balloons in the region between the Avre and Roye in 1916 and 1917.

DIRECTIONS OF EXECUTION.

I—Duties of the Balloons.

Importance of the duties of command and of observation fire on temporary targets; necessity to manage to be ready for obser·

vation fire for the benefit of the artillery groups as soon as these are in position.

Each Army Corps has three balloons at its disposal:

One to each Infantry Division.

One to the Army Corps, Command and Heavy Artillery Balloon.

II—Liaisons.

The attention of all is called on the importance of the close touch between the balloon and the Post-Command of the large unit, either Army Corps or Infantry Division Post-Command to which it is connected. **To this Post-Command the balloon should give all information and receive all orders from it.**

In some cases, it is necessary also that the balloons connect immediately with the Divisional Artillery or with Heavy Artillery, then to the nearest Artillery Groups, particularly with the groups of the Heavy Artillery rapid rate fire (temporary targets) as soon as these Groups are in position.

III—Transportation of Balloons.

Must be performed according to lines known in advance; as the line of points of ascent cannot be distinguished from the axle of progression of the Division of the Infantry Division balloons and from the axle of the Army Corps balloons. **Advance should be performed on this line as quickly as the artillery fire will permit.**

Exceptionally, indications had been given that, in principle, the line of the Avre should not be overreached during the first day (previous care taken on account of the difficulties in case of counter-attack during the night.)

IV—The Advance from the Point of View of Balloon Transportation

The zone to be reached immediately by the balloons comprised:

1°—A zone quite unsettled of about 4 km. (region of Castel, Mailly-Raineval, Grivenes, Mesnil-St.-Georges.)

2°—An obstacle, the swampy Avre, from which all the passages had been destroyed by the enemy in the portion recently abandoned.

Tools had been foreseen for the passage of the first zone, winches, tenders and small trucks only were supposed to break through before the first repairs were made.

Crossing the Avre offered difficulties. Reconnaissance of the points of passage had been made and study of photos. Indications had been given, recollection of the occupation in 1916.

The companies were supposed to make a detour at their first winch in order to use either the bridges of the northern passage (which was in French zone before the attack) or the bridges that were first replaced; after the crossings balloons could then be hauled in over the winches which have thus been carried over.

The 80th Company had been placed in reserve to the north on the transversal of DOMARD-MOREUIL-MONTDIDIER, ready to substitute for a company that would encounter an insurmountable obstacle (1.)

PARTICULAR POINTS.

(a) Convoy.

The march should be performed in two echelons, Combat train and Park train, the latter clearly autonomous, having a fixed itinerary and staying 4 km. at least in rear of the balloon. This park comprised a lot of 100 tubes (two other reserves had been constituted, one of 200 tubes northward up to the companies on the transversal DOMARD-MONTDIDIER, the other of 160 tubes, southward in the region of COIVREL-MAIGNELEY); these two lots were on wheels (trucks from the Reserve Companies.)

(1) On the 10th, the Avre was greatly overreached by all the companies. The 80th Company, having come to Pierrepont, received the 31st Balloon, which crossed the river while ascended (composing elements of the 9th Army Corps and put in reserve.) In the evening of the 10th, the companies were on the general line: Arvillers-Hangest-Contoirs-Fignieres-Faverolles-Vaux, preceding the artillery, which gradually took position in the vicinity of the balloons. From this moment the advance with less rapidity was of no real serious difficulty for the balloons.

(b) Wireless Liaison and Telephone.

A K or U alternator per Army Corps, in addition to the Gueritot of the companies, the range of which was increased by doubling the earth surface.

Prohibition to place any light wire line in order to avoid too long telephone connections and too great a number. Use of portions of fixed lines left by the enemy.

EXECUTION.

The surprise of the enemy was complete and he retreated immediately. The advance of the balloons started early on the 8th; the moments of bad visibility were employed for the pro-

gression, the balloon was always in position in case of necessity and organization of a partial attack.

The balloons kept close to their Division.

Early on the 9th the Avre was crossed by the balloons of the 31st Army Corps. While such a rapid advance, the difficulty was not only to follow the Division and the artillery, but above all to remain in close touch with them.

Observation was easily performed because of the locations of the balloons in the vicinity of the lines; but the transmission of gathered information was also to be secured; it was equally necessary to have owing to the liaisons with the artillery, the means to destroy all the objectives that were in sight.

BRINGING ABOUT OF LIAISONS.

All stops of the balloon were made near a Division or an Army Corps Post-Command.

The sending station of the wireless telegraphy was immediately established, the first telephone line was placed at the same same time.

(A) The wireless telegraphy station transmitted all information regarding the Command as well as the German Trench Battery until the telephone line connected with the Post-Command was established.

As soon as the liaison was made it only transmitted the German Trench Battery.

Owing to the immediate proximity of the Balloon and of the Groups, Gueritot posts were always heard by the Artillery Groups, but sometimes so weakly that they would not have been heard if numerous radio messages had been sent by planes.

(B) Telephone connection with the Post-Command immediately took place; was always preceded and then duplicated by runners.

The balloon situated by the side of the artillery in the middle of the Groups constituted a real point of attraction for these, having no observation posts. They then took the initiative to construct themselves a telephone line coming from the winch; these Groups also often sent officers in liaison with the balloon in order to give useful indications to the observation fire, especially for adaptation fire. Officers from Groups also came to the balloon to be informed as to the progress of the attack; to be informed of what was seen by the observer, etc. As several Groups were

still unaware of the balloon wireless telegraphy, the observers received orders that transmissions be effected by the balloon when the liaison was made with the Group to make sure of the receipt; they also indicated the emplacements where the panels should be located for the adjustments by wireless which might be necessary.

PERFORMANCE OF DUTIES.

1°—Duties of the Command.

In course of the 8th, 9th, 10th and 11th days of attack, the balloons gave information which was very much appreciated by the Army Corps or Infantry Division elements (as example: observations performed by balloon 38 during these four days) marking out panels were observed, groups of men were spotted, the work of the tanks followed, besides all observations referring to the general work of attacks and rockets.

The close touch of the balloons with the Post-Command, brought this information instantaneously to the Chief of Staff or to the 3rd Bùreau.

Telephone communications permitted this instantaneous transmission and a complete copy of the information was often carried off immediately by runner, this owing to the proximity of the Post-Command.

The result of this was that the balloon became for most of the Division the eye from which the Command could see the whole of the battle field; although this role of the balloon was not a new thing for the Army Corps, it was new for the Divisions. In the sector, the balloon is above all a Divisional Artillery element. It seldom has opportunity of furnishing information to the Command of the Division.

The Division balloon has not only surprised the Generals Commanding the Division by the information it could give and the liaison that it could maintain, but they were especially surprised at the rapid progression that permitted it to precede the Post-Command; without hesitation took position at 4 kms. from the lines in the middle of the Groups of 75s, and helping these to carry out the adaptation fire as soon as they arrived.

Therefore, never closer connection had been established between balloons and Division Staffs; the result of this close connection was that the balloon became a necesstiy for the Division, the latter no more performing the least operation without having

informed the balloon of all the details. Passed in reserve some Colonels and Chiefs of Battalion of Infantry came to ascent in **their balloon.**

2°—Duties of the Artillery.

The work to be done for the benefit of the artillery was the difficult part; but largely facilitated by the situation of the balloons in the middle of the Groups. The wireless transmission of the German Trench Battery, the telephone communications rapidly established with the rapid rate fire Heavy Artillery Groups, and with the nearest groups gave in all cases immediate results.

As soon as an objective was signalled by wireless telegraphy and shots fired in the region of the objective, the balloon, although not knowing who fired, the position of the shots was signalled by wireless telegraphy with indication by cardinal points.

The objectives will be signalled according to the case: To the Groups firing on temporary targets (numerous control fire of this kind has been made) ; to the Divisional Artillery or to the Heavy Artillery, which immediately notified the Group of observation fire.

In course of one day only, on August 11th, the the number of observations was weak, but this happened because on that day nearly all the total number of the artillery moved without being able to fire according to the balloon's signals.

3°—Numerical Results.

9th A. C. Aug. 8.	10° A. C. Aug. 8-25	31° A. C. Aug. 8-25	35° A. C. Aug. 8-25	
Adj-Count Batt. ust. Batt.	Adj-Count Batt. ust. Batt. ment.	Adj-Count Batt. ment. Batt.	Adj-Coun. Batt. ment. BBatt.	
21 10 2	271 105 12	206 120 27	304 122 41	

General Totals—802 batteries spotted; 439 observation fire.

It is to be noted that there being no ground observation, the non-functioning of the sound and flash ranges section gave a particular importance as to the marking out of the German Trench Battery by the balloon.

On the whole, what characterized the observation of balloons from the 8th to the 12th of August was:

1°—The rapidity of the progression and the maintenance of the balloons in the proximity of the lines, whence the

possibility to carry out interesting observations in spite of unfavorable circumstances.

2°—Continuance of observation and particularly the continuation of the work for the benefit of the artillery.

3°—Close liaison between the balloons and Division Post-Command, as the balloon would endeavor to make all observations in course of all attacks for the profit of its Division.

On the other hand, the balloon's position in the middle of the Groups or beyond the heavy artillery facilitated the work of the artillery.

JUST ESTIMATE OF THE BALLOON PERSONNEL IN COURSE OF THIS ADVANCE.

A—Balloon Commanding Officers of Army Corps.

Remained at the Corps Command-Post and were not active enough, and remaining too short a time among the companies, so as to guide them, to find out their needs and to facilitate their task; also giving brief orders from a distance, fixing points of ascent, points of cantonment.

It was necessary to interfere in order to obtain all initiative on behalf of the Unit Commanding Officers.

The Balloon Commanding Officer is too much like an element of the companies, asking for their report at a certain hour.

The Balloon Officers were inclined to play the part of Intelligence Officers instead of that of a Unit Group Commanding Officers.

The Balloon Commanding Officers are nevertheless excusable.

Their Command is not organized, they have no assistant, and between the desire of permanence at the Post-Command or at the Army Corps or to follow their companies, they have chosen the permanence.

B—Unit Commanding Officers.

Have all shown high spirit, having clearly understood their part in the battle, glad to walk ahead. On the other hand they need to acquire a practical improvement course, a complete knowledge of their role regarding the functioning of a company while in progression. They do not know how to organize the liaisons, not understanding at first the capital importance of it in a war of movement; they do not know either how to organize the reconnaissance of their itinerary in course of displacements.

C—The Observers.

Have not always shown all the go expected from them. The circumstances proved a great number to be indifferent and others would not understand that the liaison could be made without a light with only two or three kms. walk.

General evenness of observers is the weakest point in the Balloon Service at the present time.

It appeared in a particularly striking manner in course of this period where everyone was supposed to be ready and to act accordingly.

To be exact, it must be stated on the other hand, that some of the observers are worthy of praise, as they were always ready to ascend when some of their comrades were not available.

It is to be noted that for a period of displacement, the actual number of observers is quite insufficient; a few companies only disposed of four observers (some observers being in schools, evacuated or on leave.)

Under these conditions, perfect liaisons are difficult to obtain, owing to the constant displacement of the elements with which these liaisons must be maintained. It would be necessary to have five observers per company. One observer could then be placed in permanence at the Division, or one with Heavy Artillery. This is indispensible.

D—Troop Personnel.

Proved to be above all expectation. In spite of the weariness, the aeronauts wanted to prove that they could advance as quickly and even quicker than the other troops. When the companies had to be placed in reserve, although very tired, they were very much distressed not to continue the progression.

Material.

As usual was very heavy. The companies have too many vehicles that have to be left behind. The trailers were hindrances. A few saddle horses were unanimously desired.

Supply.

Each company having 100 tubes and transversal reserves of 360 tubes having been constituted, the question of supply was only taken into consideration after the first days of advance. At this moment, reconstruction of the bridges allowed the passage of a material reserve on wheels, beyond Montdidier. Gasoline was

delivered there, tubes and all the material. As soon as the railroad was rebuilt, the tube depot itself was removed to MONTDIDIER.

CONCLUSION.

From August 8th the advance of the balloons was performed rapidly. The liaisons were well maintained with the elements to which disposal of the balloons had been placed.

The personnel assigned for the maneuvers of the balloons has accomplished its task with satisfaction. Nothing to be added to what has been said about the rolling material, which is too heavy and had to be left behind systematically.

The non-organization of the Aerostation Command of Army Corps signalled after the operations of March and April, continued to be a source of difficulties that individual initiatives are not capable to resolve.

(Signed) MACHERAT.

ANNEX.

Displacements of companies gave rise to the following observation.

1°—The Station of the Company's Commanding Officer.

The Commanding Officers of companies are often unfindable during the displacements. They secure the liaisons or make for distance reconnaissaance. The officer in charge of the movement operation, being left alone, has no information regarding the situation and stops sometimes waiting for orders.

On the other hand, the observers are near the winch, or they are charged to conduct the Park convoy.

The station of the Company's Commanding Officer during the displacements should be in the vicinity of the balloon, ahead most of the time with liaison agents in order to make reconnaissance of the way; there he can best act and receive orders or information which will keep him informed of the changes in the situation,

The observers are in charge of the liaisons with the exception of the one who is in the balloon car or ready to ascend.

(a) One observer for the Division or for Heavy Artillery, with two cyclist liaison agents. This observer keeps the Com-

manding Officer of the company informed of the situation and transmits the orders.

(b) The other observers establish the artillery liaison by keeping in close touch with the Groups.

2°—The Reconnaissance.

The Commanding Officers of the companies do not take enough advantage of the halts to consider in detail their probable itinerary before the displacement is to be effected. (This remark applies especially to the resumption of the movement on August 27, as the Commanding Officers of the companies contented themselves with too superficial reconnaissances and have not foreseen the case which happened, rain and wind.) The advance was performed, but at the price of considerable effort.

3°—Moving of the Parks.

The Commanding Officers of the companies always hesitate to choose for their parks a good road distinct from the track which they follow with their balloon, whence slowness and difficulties which often necessitated the intervention of the company to free the vehicles, which could easily have taken a better road.

A Commanding Officer of a company brought all his park at about 4 kms. from the lines, then reported that he had no more gasoline. This lack of foreknowledge compelled him to supply with extreme urgency.

MACHERAT

THE WEEKLY
BULLETIN

OF THE SCHOOL OF INSTRUCTION
ARMY BALLOON SCHOOL
ARCADIA, CALIF.

Vol. 1, No. 12 **Thursday, Dec. 12, 1918**

Edited by R. A. Drake, 2nd Lieut. A. S. M. A.

A Medium for Collecting and Imparting Information in Regard to Balloon Observation

FOR OFFICIAL USE ONLY

CONTENTS OF THIS ISSUE

SPECIAL NOTICE

The information in the Weekly Bulletin is extremely valuable for balloon observers. All officers should become familiar with its contents, and the instructor officers in particular will be held responsible for the facts published weekly.

It is suggested that all copies of the Bulletin be filed so that they will be available for future use.

THEODORE H. MAENNER,
Capt. S. C., (Aero.)

NOTICE.

Commissioned Officers of the Army Balloon School at Arcadia may obtain copies of the Weekly Bulletin after 1 o'clock on the Thursday of each week, by applying in person to Lieut. Drake's office in the Instruction Building. Copies of each week's issue will be available until the supply is exhausted.

HISTORY OF UNITED STATES ARMY BALLOON SCHOOL, ARCADIA, CALIFORNIA.

I.

About March 13th, 1918, Colonel W. N. Hensley, Jr., came to Arcadia, California, with three lieutenants, preparatory to organizing a balloon school. Some equipment came at this time, but it was not until later that additional officers and men arrived. June 12th, two companies arrived from Camp John Wise, Texas, and one from Ft. Omaha, Neb. Four other balloon companies increased the size of the camp later in July.

On May 13th, 1918, authority to start construction of the Balloon School, Arcadia, California, was received. The estimated cost was $360,000. On June 18th the actual construction of offices, storerooms and latrines commenced. By September 26th, 1918, but one hundred and one days from the time the actual construction began, all construction from the original plans was completed. On October 10th, the following buildings were accepted as conforming to specifications: 10 mess halls, 8 barracks, 4 latrines and bath houses, 5 hose house buildings, in addition to the Commanding Officer's quarters, the Hospital, Guard House, Company Store Building, Post Exchange, Post Headquarters, Aero Supply and Quartermasters' Supply Building, two additional latrines, Officers' Mess, Photo Laboratory, converted Company store, Sanitary Sewers, Gas Mains and Water Works. By November 20th, seven Company Headquarters and the Post Signal Office were completed.

During this work of construction, the actual work of getting balloons in the air for instruction purposes, was rapidly being accomplished.

On June 16th, two days before actual construction began, the first balloon was filled from cylinders brought to Arcadia from Ft. Omaha, Neb., by the 66th Balloon Company.

Manufacture of gas at the Arcadia Camp was delayed, owing to the fact that on July 12th the first silicon plant was received in a damaged condition, but in a week's time the plant was repaired and gas was made. By June 23rd

two balloons were flying; by July 10th four balloons. By this latter date there were fourteen officers and seventeen cadets on the flight list. The officers of the post, from the Commanding Officer down, were taking the twenty-four-hour passing out course that had been outlined by Washington. Ten men were qualified as Aerial Observers according to the qualifications then existing, by July 20th, 1918. About this time cadets began to arrive in larger numbers to take the air course. July 27th saw one hundred and one cadets enrolled at the Post.

The number of balloons in the air steadily kept pace with the increasing number of students. By July 27th, six balloons were flying regularly.

To instruct the students in the elements of observation, each day an auto truck carried up Mt. Wilson (altitude 5886 feet, affording a remarkable view of the same country as observed from the balloon) cadets who spent the day studying the territory and observing simulated battery flashes. The success of this method of instruction was instantly apparent. A number of the students could learn the fundamentals of the work simultaneously without having their attention distracted by the disconcerting sensation of being in a balloon basket. Further developments of this instruction were confidently awaited.

August 5th saw the maximum number of balloons in the air—eight. Three officers and ten cadets were the first students to complete the twenty-four hours advanced flying course. Date, August 10th, 1918. The ten cadets were immediately recommended for commissions.

The school was now well organized. The work was well systematized and the greatest effort was over. It appears to be a simple task to inflate eight balloons and keep them in the air from sunrise to sunset. However, the construction of balloon beds, the maintainance of the repair shop for keeping the balloons in good condition, the manufacture of hydrogen gas, the surveying of the country and staking out of targets, the bombing and flashing to simulate enemy batteries firing, the construction of telephonic lines, mapping the country and tabulating the detailed information sent down by the balloons—each of these problems

required painstaking and faithful work to accomplish the results that were accomplished.

The spirit of co-operation with the authorities, both military and civil, made the Arcadia Balloon School stand out as one of the best examples of a disciplined military institution from the start. The enlisted men were contented, their morale was always high, and their good conduct led to the extension of privileges that were scarcely ever abused.

A magnificent swimming pool aided materially in providing an excellent means of amusement and exercise.

The post band of twenty-eight members, together with the formal guard mount, added a very welcome touch of military formality that subtly increased the growing esprit de corps.

An enlisted mens' paper, "The Observer," edited and published by selected men of the companies, was a medium for the interchange of ideas and personalities that has been most helpful.

II

The second era of the Arcadia Balloon School, if it can be called such, was instituted when, at the advice of the French Mission, the ground course for observers was transferred from Ft. Omaha, Neb., to Arcadia. This meant that, essentially, the Arcadia Balloon School was not to be merely a flying school, but a school that would give the student, in addition to air work, the very essential ground training that is preliminary to his air work.

About the middle of September, 1918, a large part of the staff of the Omaha Ground School was transferred to Arcadia. Under the supervision of the experts of the French Mission, who furnished outlines for the courses and supplied the latest information, the instructors organized courses in the following subjects:

Artillery for Balloon Observers.

Aerial Photography.

Panoramic Perspective.

Observation and Orientation.

Illustrated pamphlets were printed in each of these subjects, giving the lectures in full. A confidential Weekly

Bulletin, printed for the officers, informed them of all the new developments that were taking place abroad.

The first students to take this revised ground course were the officers in the Post—again from the Commanding Officer down.

As the work in the balloon basket was the most expensive and most liable to interruption, more and more work was instituted on the ground. Stereopticon slides were made of simulated shell bursts—single rounds and salvo fire—so that in the artillery laboratory, students could observe these flashes and locate them exactly as they did in the balloon. Maps and vertical aerial photographs were furnished for this work.

The Arcadia School was the first balloon School to have the exclusive use of aeroplanes to photograph the targets observed from the balloon. Prints of these targets were used to correct the students' maps in the photography laboratory before the student went up into the balloon. Oblique and vertical aerial photographs were used largely in the mountain observation work to help the student learn the territory, and in the balloon basket a complete file of the targets on which artillery fire was regulated, was furnished. This was a tremendous step taken in the right direction.

Early in October the further development of the mountain observation camp was instituted. So much time had been lost going to and from the mountains every day that a camp was constructed on one of the highest peaks, and as soon as the mist cleared away in the morning the students were in the observation building studying the territory spread out below them, or directing simulated artillery fire. In the evenings the students continued to correct their maps (later to be used in the balloon basket) coloring in prominent orchards, washes, or other salient points, correcting their maps, adding names of roads, railroads, towns, etc.

The main flight course was but slightly altered. Longer flights were instituted, additional precautions were taken to combat the threat of the "Santa Ana's"—wind storms from the desert. The establishment of a centralized chart room was also in the nature of development rather than a change.

A model chart room and basket gave the students con-

crete ideas as to how their work should be accomplished in the air and on the ground. Direct supervision of these centralized chart rooms was a valuable aid to increasing the student's efficiency in very important work of record keeping.

Situating of the front lines by means of powder smudges simulating Bengal fires was a development that has probably never been instituted in any balloon school except at that greatest school of all—the front.

Improved balloon beds—blasting out the old grand stand facing the race track to provide wind protection and drainage facilities for the coming winter, development of basket and balloon equipment, a constantly increasing number of vertical and oblique photographs of the environs of the balloon school, construction of a telephone line connecting Mt. Wilson with the balloon school proper, constant improvement of both the quality of the gas (99.2 per cent pure hydrogen) and quantity (20,000 cubic feet) per hour by September 12, 1918—sufficient for eight or nine balloons of the Cacquot type, improved maps* for use in the laboratories and in the balloon basket—all these were a result of the essential and excellent work of the balloon school's "S. O. S.," that constantly had the one ideal in view, i. e., to make Arcadia the best and most efficient balloon school in the world.

The work of the enlisted specialists, school had been going forward steadily. In addition to the development of a "flying" target for machine gun practice, *the training of chart room specialists, telephone men **and rigging repair men, had been successfully keeping pace with the constantly increasing demands from Washington.

On October 1st, Col. W. N. Hensley, Jr., was relieved from active command of the Post by Major Max C. Fleischmann. Major Fleischmann's aid in procuring the French Mission and inspecting the work of the balloon schools dur-

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*A silhouette aeroplane which slides across skyline on cable 400 meters distant—range situated in canyon north of Balloon School.

**By using an army balloon as a support for one end of the atennae, at a height of 2800 feet, the Balloon School was enabled to receive wireless messages from the Brooklyn Navy Yard, more than three thousand miles away.

ing the times of greatest difficulty, had already made him well known to the members of the balloon school staff, so that the change of Commanding Officers was accomplished without the loss of a moment in the steadily increasing efficiency of the school.

The number of accidents in connection with the operation of the balloon school has been exceptionally small and the health of the command good. On August 10th a Cacquot balloon broke away, carrying seven hundred and fifty feet of cable. A rip landing was made with the balloon undamaged. The explosion of a cannon used by the bombing detail caused two deaths and wounded several men.

On October 17th a balloon exploded while in the air, but the cadet in the basket was not seriously injured. In another instance, on October 18th, a lieutenant, who was in a balloon that broke loose from the winch, descended safely in a parachute. These are the outstanding accidents that endangered the lives of the personnel of the Post to any extent.

The influenza epidemic was successfully combated in this camp. On October 25th, when the influenza epidemic was at its height, there were one hundred and thirty-seven influenza and fifteen pneumonia cases in the hospital. By November 8th, there were ninety-six cases of influenza and thirty-five of pneumonia. Twelve deaths resulted from pneumonia, but none from influenza.

The results accomplished by the school in the training of observers affords the best conclusion to this resume of the school's activities. The following table is self explanatory:

June 12, 1918 (Date the First Balloon Ascended) to December 6, 1918.

Number of Cadets commissioned as Officers	116
Number of Observers rated at Arcadia*	126
Number of Maneuvering Officers recommended at Arcadia	37
Total number of Officers and Cadets who received some training at Arcadia	344

*NOTE: 13 men completed Air Course at Arcadia, but were ordered away before completing Aerial Ground Course.

(Not to be communicated to anyone outside the Royal Naval Air Service)

THEORY OF BALLOONING

A COURSE OF FOUR LECTURES
ON
THE THEORY OF BALLOONING

DELIVERED BEFORE OFFICERS AT THE ROYAL NAVAL AIR STATION, ROEHAMPTON

OBTAINED FROM PRACTICE

BY GRIFFITH BREWER

Reprint for confidential use of the United States Army Balloon School
Authorized by the author, October 17, 1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

PREFACE TO THIRD EDITION.

In January, 1916, when I was invited to lecture on ballooning to officers in training at the Royal Naval Air Station, Roehampton, no textbook was available which could be followed for instruction in the theory of ballooning. A temporary edition of four lectures was hastily compiled, giving an outline of the lectures, which gradually developed and assumed more concrete form. Later an illustrated edition of the lectures appeared, and these, with various reprints, have since been used during the past 18 months.

The third edition is more ambitious than its predecessors, for it now aims at the production of a textbook for imparting the principles of aerostation while omitting all unnecessary complications and mathematics. By reading the textbook and attending the lectures it is hoped that a novice may gather an understanding of the theory of ballooning which will qualify him to solve each problem for himself as it arises. It would be hopeless to attempt to give answers to all balloon problems, because they are so numerous that after a hundred ascents new problems will still be met. If, therefore, the officer be equipped with a knowledge enabling him to reason out each problem for himself, he may continue to acquire in practice a knowledge not only of the theory, but also of the science of ballooning.

GRIFFITH BREWER,
9 Galen Place, W. C. 1.

JULY, 1917.

FIRST LECTURE.

THE SCIENCE OF BALLOONING.

The science of ballooning is so simple that few have taken the trouble to thoroughly master its rudiments, and thus, by leaving some elementary point misunderstood, many have practiced the art for years in an unsatisfactory way. For this reason I am particularly anxious that none of you should let even the most elementary fact pass which you do not understand.

THE PRINCIPLES OF DISPLACEMENT LIFT.

If a body be completely immersed in water, it displaces a quantity of that fluid equal to its own volume. If the weight of water thus displaced be less than the weight of the body immersed, the body sinks to the base of the vessel containing the water. If, on the other hand, the weight of water displaced exceeds the weight of the immersed body, the latter rises to the surface.

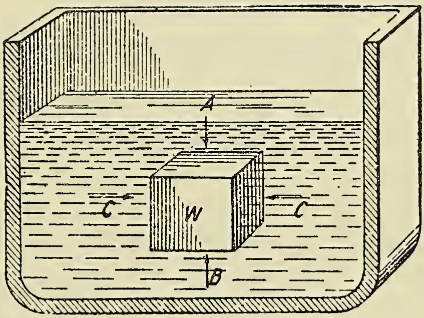

FIG. 1.

Referring to figure 1, a cube is shown immersed in a tank containing water which presses on all of the six faces of the cube. The pressure C on the four sides can be regarded as crushing pressures, having no effect on the buoyancy of the cube. The pressure A on the upper face

tends to depress the cube toward the base of the tank, and the pressure B on the lower face tends to lift the cube toward the surface. If the weight of the cube exactly equals the weight of a similar quantity of water, the cube is in a state of equilibrium, because the pressure A is less than the pressure B by the weight of a volume of water equal to the volume of the cube. If W exceeds the weight of the water displaced, then A + W are greater than B, and the cube sinks. If W is less than the weight of the water displaced, then A + W are less than B, and B forces the cube to the surface.

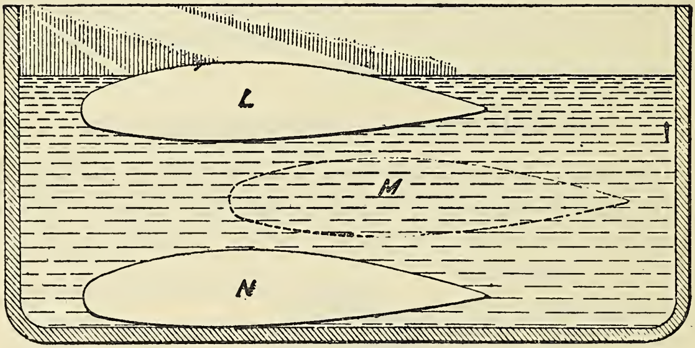

FIG. 2.

A model submarine, shown in figure 2, if of less weight than the weight of water equal to its own volume, floats as shown at L; but, if water be admitted to its ballast tanks sufficient in weight to cause it to submerge, it sinks below the surface as at M. It is impossible to so accurately admit water to the balance tanks as to leave the submarine permanently at M, and, consequently, once below the surface it continues to sink to the base of the tank, even though this be of infinite depth. Unless a submarine is kept under way, when it can be steered up or down on inclined planes, it must either float with a portion exposed above the surface, or sink to the bottom at a speed

depending on the excess of its weight over the weight of water displaced.

Fig. 3 illustrates a tank having an overflow pipe and a bucket ready to receive water overflowing. If a model vessel be placed in the tank when the water is up to the level of the overflow pipe, the water displaced by the model will flow through the overflow into the bucket. The weight of the water received in the bucket will be equal to the weight of the floating model.

COMPARISON OF WATER AND ATMOSPHERE.

All fluids, both liquids and gases, have weight. Water weighs about 800 times the weight of air for a given

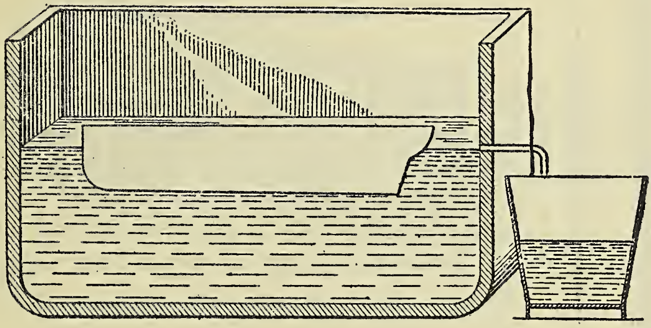

FIG. 3.

volume. There is, however, a great difference between a liquid and a gas, in that the liquid is elastic to a very small degree, while gas changes in volume immensely under changes in pressure and heat.

In comparing the relative effects of water and atmospheric displacements this difference must be always borne in mind, for it causes a body of fixed displacement which is slightly heavier than water to continue to descend indefinitely, whereas a body of fixed displacement slightly lighter than air would, if it could be so con-

structed, rise with diminishing lifting force until it arrived at a point of equilibrium where it would displace its own weight of air only, and the reduction of lift in further ascent would prevent its continuing to ascend, while increase in lift when it commenced to fall would soon restrain it from continuing to fall, with the result that it would float in the atmosphere forever. The altitude of such an imaginary balloon would vary with the changes of atmospheric density, but these would confine its path of flotation within a belt of perhaps 3,000 feet—say between 5,000 and 8,000 feet—above sea level.

FIG. 4.

ATMOSPHERIC DENSITY.

The atmosphere decreases in density as the altitude increases. As the density of the atmosphere decreases its weight per volume decreases in proportion. For instance, at 19,000 feet altitude a cubic foot of atmosphere weighs about half the weight of a cubic foot of atmosphere at sea level. Gases, being elastic, expand with decreased pressure, so if 1 cubic foot of atmosphere, or other gas, at sea level be taken to 19,000 feet altitude it will, if unrestrained, gradually expand to a volume of 2 cubic feet when it arrives at 19,000 feet. The pressure of atmosphere at sea level is about 15 pounds per square inch, and at 19,000 feet altitude the pressure is $7\frac{1}{2}$ pounds per square inch; consequently if a nonelastic vessel containing atmosphere or other gas be filled with 1 cubic foot of such gas at sea level and the vessel then be sealed, when it arrives at 19,000 feet altitude the internal pressure in the vessel will be at $7\frac{1}{2}$ pounds per square inch.

The barometer is an instrument for measuring the weight or pressure of the atmosphere. It consists of a glass U tube, having one arm sealed and the other open at atmospheric pressure. Mercury, which weighs about one-half pound per cubic inch, is filled into the tube, and no air is left between the sealed end and the mercury. The U tube must have the sealed arm of greater height than 30 inches, so as to permit the surface of the mercury to fall below the sealed end. The diagram at figure 4 shows a mercury barometer in which the sealed arm is of greater height than 30 inches. The shorter arm, which is open to the atmosphere, is shorter in height and is

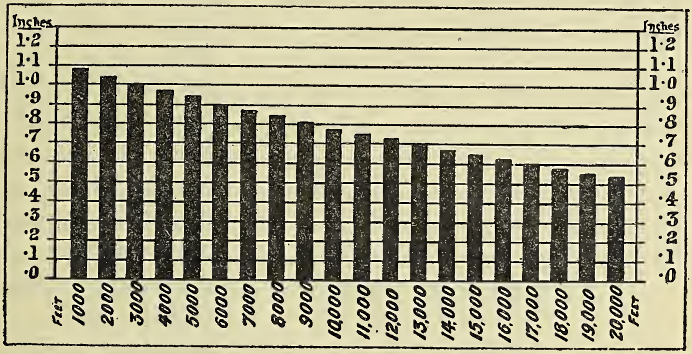

Fig. 5.

larger in area, in order to obtain the greater part of the movement in the height of the mercury column in the sealed arm, instead of half the movement in each arm, which would be the effect if both were of even diameter.

The action of the barometer is to weigh a column of atmosphere against a column of mercury. In the arm which is sealed the mercury has no air pressure or weight upon its surface, whereas in the arm which is exposed to the air the atmospheric weight is allowed to rest upon the mercury surface. Hence the difference in the heights of the two columns. The diameter of the exposed surface does not affect the height of the mercury.

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The diagram (fig. 5) illustrates the gradual diminution of pressure for steps of 1,000 feet in altitude above sea level.

The atmosphere resting on the mercury imparts a pressure, due to its weight, and the atmospheric column thus weighed may be 100 miles or more in height. The atmosphere is very much heavier at the base, which is near the earth, than at the upper portion of the column far above the earth, weighing 15 pounds per square inch at the base, and yet when weighed at little more than 3 miles from the base the remainder of atmosphere above only weighs 7½ pounds. Thus half the earth's atmosphere is within 3 miles of sea level and the remaining half is gradually dispersed to unknown heights above.

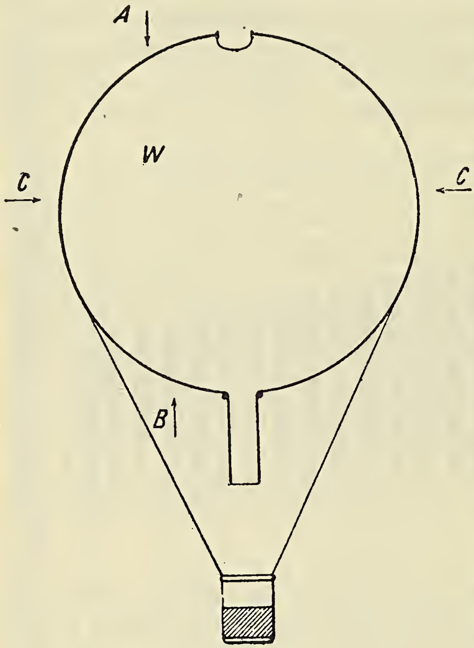


Fig. 6.

A balloon floating in the air is supported in a similar manner to the bodies immersed in water, above referred to. At figure 6 a balloon is illustrated, consisting of the balloon envelope, to which is suspended, by means of a net, the hoop and the car containing the passengers and ballast. The air pressure A on the upper portion of the balloon is less than the air pressure B on the lower por-

tion of the balloon, and if $A+W=B$, the balloon floats in equilibrium. W in this case represents the weight of the balloon and all that is attached to it, and it also includes the weight of the gas. Consequently, if the gas be hydrogen, weighing only 5 pounds per 1,000 cubic feet, the pressure B will support more weight in the car than if the gas be coal gas weighing, say, 35 pounds per 1,000 cubic feet. At sea level, where the atmosphere weighs, say, 75 pounds per 1,000 cubic feet, 40,000 cubic feet of air will weigh 3,000 pounds. This same volume of hydrogen, weighing about 200 pounds, leaves 2,800 pounds to complete the weight W, and if the balloon and gear weigh 400 pounds there is a margin of 2,400 pounds for lifting passengers and ballast. If coal gas weighing 35 pounds per 1,000 cubic feet be used to inflate the same balloon, then the gas weighing 1,400 pounds, this, when subtracted from the weight of air displaced, leaves only 1,600 pounds of lifting effect, and from this the weight of 400 pounds, representing the balloon and gear, has to be subtracted. Only 1,200 pounds of lift is therefore available for the passengers and ballast, as against 2,400 pounds useful lift if hydrogen had been employed.

THE SPHERICAL BALLOON.

The ordinary free balloon consists of a gas bag, which is made in spherical form for several reasons:

1. The largest quantity of lifting gas for a given weight of material can be contained in a spherical envelope, and so the greatest lifting efficiency is thus obtained.
2. The strains of expansion are most evenly distributed in a sphere.
3. The weight to be carried by the car can be evenly and easily distributed over the envelope by means of a net which terminates in a number of ropes, each bearing its fair proportion of strain.

FUNCTION OF THE GAS.

The gas in the envelope always tends to rise, hence it is possible to leave the mouth or appendix at the base of the balloon open without the gas escaping. The gas can only be let off at the top, and for this reason the valve for permitting gas to escape is situated at the upper part of the envelope, the cord for controlling the valve passing down through the center of the balloon and appendix to the hoop above the car, ready to hand for the pilot when he wishes to allow some of the lifting power to escape. The valve is normally kept closed by springs, and the valve cord enables the valve to be opened downward against the springs.

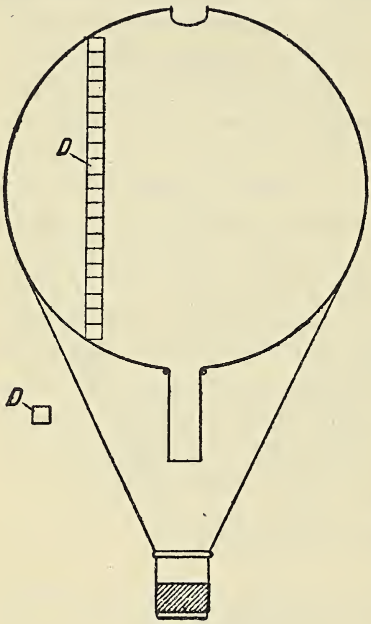


FIG. 7.

Roughly speaking, 1,000 cubic feet of hydrogen displaces 75 pounds of air, and as it weighs only 5 pounds itself it has a lifting power of 70 pounds. One cubic foot of hydrogen, therefore, has a lifting power of about $1\frac{1}{10}$ ounces.

To gather a clear idea of the function of the gas in a balloon, you may think of the hydrogen in cubic feet D piled one on the other, each trying to rise under a 1-ounce lift. If the balloon be 40 feet from top to bottom, these 40 cubic feet will be lifting each other, and their cumulative support below the top cube will be 39 ounces. This is the opposite effect to that of cubes of water piled

on each other, where the cubes above all press down on the cubes below.

Another way to appreciate the effect of gas in a balloon is to remember that it has the opposite effect to a fluid heavier than air, such as water. You can pour water into a bottle with the neck upward, but you can not thus pour hydrogen. On the other hand, you can pour hydrogen upward into a bottle with the neck downward, but you can not pour water upward.

The above are essential features of a spherical balloon, and are sufficient for the purpose of considering the ordinary starting working of a balloon in calm air.

PILOTING.

When the balloon is inflated and the passengers, pilot, and an excess of ballast are in the car, the lifting power of the balloon is adjusted by taking out bags of ballast until the car is found to lift.

If the balloon be released with too much lifting power, she will rise very rapidly and waste a considerable amount of gas; if too little lift be given, she will rise slowly and may possibly collide with trees or the gasometer at the ground.

In navigating a balloon the greatest care should be taken to economize ballast, for the greater the reserve of ballast the greater is the control at the disposal of the pilot in regulating the flight and final landing of the balloon. Careless piloting may result in an enforced landing comparatively soon after starting.

THEORY OF BALLOON EQUILIBRIUM.

We will first consider the piloting of a balloon in easy weather conditions and observe the effect of discharging ballast and of releasing gas.

Assume the balloon to be exactly balanced with ballast so that if released it hesitates whether to remain on the

ground or to rise in the air. If the air be calm, by discharging 10 pounds weight of ballast the balloon will commence to rise under the influence of a 10-pound ascending force. The rise will be very slow with such a small lift, and if there is any wind the balloon will drift at a low height and may hit objects on the ground. For practical purposes, therefore, an ordinary 50,000 cubic foot coal-gas balloon should not start with less lifting power than, say, 20 pounds on a calm day; and on a windy day it may be necessary to have a lifting power of perhaps 100 pounds in order to clear the trees, etc.

To go back to the theoretical instance of the balloon starting with a 10-pound lift. If the balloon be completely full of gas, and the mouth or appendix be left open in the usual way, as the balloon rises in the air the progressive decrease in the surrounding atmospheric pressure will permit the gas within the balloon to expand and overflow through the mouth. The higher atmosphere at the reduced pressure weighs less than the atmosphere on the ground, and, consequently, when the balloon has risen a short distance less weight of air is displaced by the balloon, which has remained at a constant displacement, owing to the free overflow of gas, and the lifting power of 10 pounds disappears. When the reduction of weight of air displaced amounts to 10 pounds, plus the weight of the gas which has overflowed, the balloon is again in balance. The balloon, however, has attained some speed in rising, and, in spite of the fact that it has attained its equilbrium point, it still continues to rise under the influence of its momentum.

As the balloon continues to rise, its balance is disturbed by further loss of gas caused by the further reduction of atmospheric pressure, and when the balloon comes to rest, instead of being in equilibrium, it has a descending force. The balloon therefore descends and gathers speed as it descends, and it will be necessary to discharge ballast in excess of the amount required to

bring the balloon into equilibrium, the excess of ballast used depending on the amount of momentum which the balloon has been permitted to acquire. Consequently, the slower the pilot is in discharging the necessary amount of ballast the greater excess of ballast he will be obliged to use in order to prevent the balloon coming down to the earth. He therefore discharges a sufficient quantity of ballast to acquire another lifting power, and the balloon starts on the second upward run. This time, however, the balloon does not contain so much gas as it did on the first upward run, and so it must rise to the maximum height of the first upward run before it begins

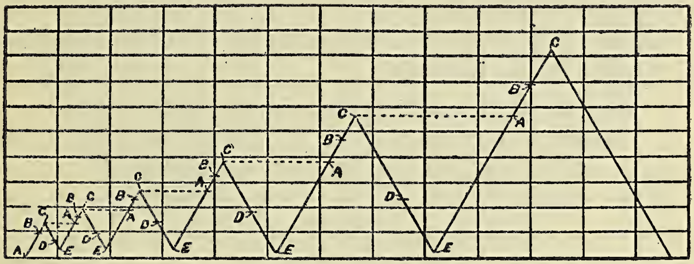


Fig. 8.

A. Balloon full, commences to waste gas in rising.
B. Equilibrium point, where displacement of air exactly equals weight of balloon.
C. Overshoot point, where excess loss of gas gives descending force.
D. Equilibrium point, on downward run.
E. Overshoot point, where excess discharge of ballast causes new rise to commence.

to discharge gas from its mouth or appendix. The gas then overflows until the balloon is again in equilibrium and continues to overflow as the balloon overshoots its new equilibrium altitude. The gas having overflowed to an extent proportionate to the speed of ascent, the balloon begins a second downward run, necessitating a further discharge of ballast before reaching the ground, and for the third time the balloon ascends and goes to a greater height than on the second occasion.

A balloon journey becomes, therefore, a series of rises and falls, each rise being higher than the last, until at the end of a four-hours' run the balloon may be rising to perhaps 4,000 or 5,000 feet.

Unless some exceptional interference occurs, the following rule may be taken as governing all balloon ascents: A rising balloon will continue to rise until it loses sufficient gas to stop it, and a falling balloon will continue to fall until sufficient ballast be discharged to stop it.

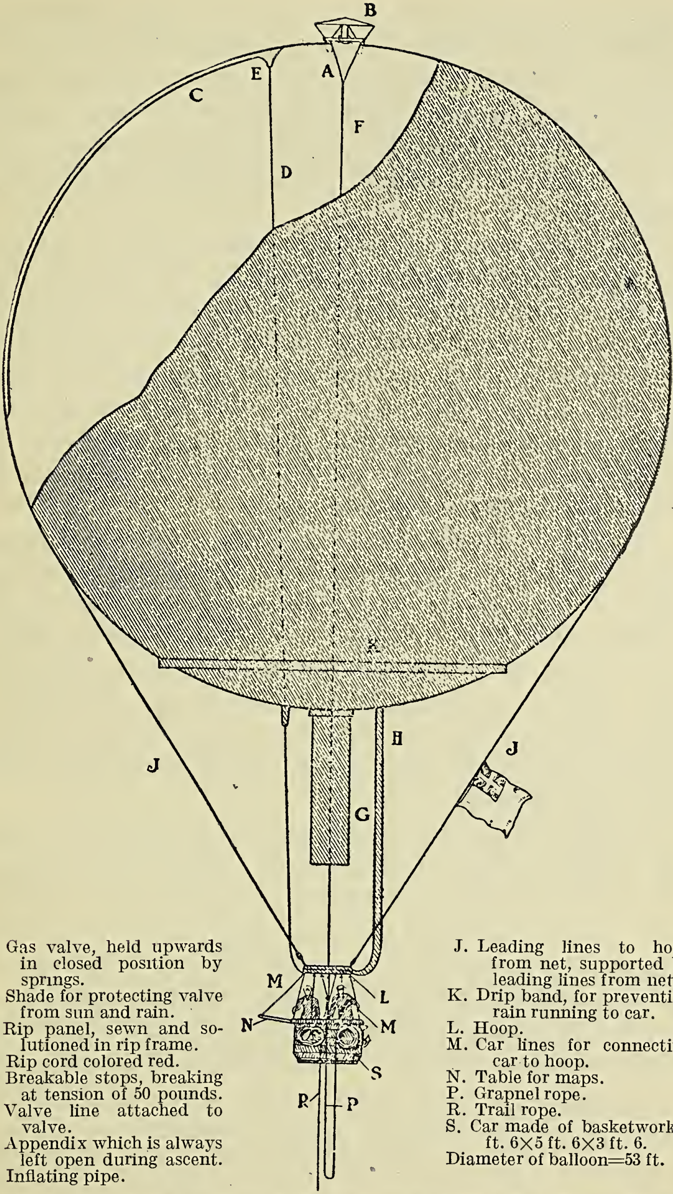
EFFECT OF CHANGES IN TEMPERATURE.

The practice of ballooning is considerably complicated by changes in the temperature of the gas contained in the envelope. There are two causes which change the volume of the gas in the balloon:

1. Change in pressure of the atmosphere.
2. Change in temperature of the gas in the balloon, relatively to the temperature of the atmosphere.

When the gas in the balloon is warmed it expands, and therefore occupies greater space, swelling out the sides of the balloon and giving the balloon greater displacement. When the gas is chilled, it contracts and permits the sides and lower portion of the balloon to be forced inward by the pressure of the atmosphere, thus reducing its displacement. Seeing that the lifting power of the balloon is dependent on its displacement of air, it will be readily recognized that heat received on the envelope from the rays of the sun disturbs the equilibrium of the balloon, and if the changes in temperature of the gas are excessive, the duration of the balloon voyage may be very much curtailed by causing excessive rises and descents to take place, with the alternate result of waste of gas and waste of ballast.

Heat from the rays of the sun is only collected when intercepted. Clear air being transparent, the rays pass through without heating it. If the rays meet an obstruc-



A. Gas valve, held upwards in closed position by springs.
B. Shade for protecting valve from sun and rain.
C. Rip panel, sewn and solutioned in rip frame.
D. Rip cord colored red.
E. Breakable stops, breaking at tension of 50 pounds.
F. Valve line attached to valve.
G. Appendix which is always left open during ascent.
H. Inflating pipe.

J. Leading lines to hoop from net, supported by leading lines from net.
K. Drip band, for preventing rain running to car.
L. Hoop.
M. Car lines for connecting car to hoop.
N. Table for maps.
P. Grapnel rope.
R. Trail rope.
S. Car made of basketwork 6 ft. 6×5 ft. 6×3 ft. 6.
Diameter of balloon=53 ft.

Fig. 9.—Illustration of 80,000 cubic foot balloon "Banshee," built for Squadron Commander John Dunville.

[Reprinted from The Field, Oct. 24, 1908.]

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tion, they are arrested in their travel and heat collects on the intercepting object. The envelope of a balloon obstructs the rays and readily collects heat in this way, and, having a large surface compared with the volume of the gas contained in it, quickly warms the gas, which expands in proportion to the heat collected. This expansion increases the lift.

Changes in volume of gas in a balloon, due to changes in atmospheric pressure, do not affect the lifting power, because as the volume of the gas increases the weight per cubic foot of the atmosphere displaced decreases in similar proportion. It is only when the volume of the balloon ceases to increase by reason of the gas overflowing when the balloon becomes full that lifting power begins to be lost, owing to decreasing weight of the air displaced by the balloon as it continues to rise.

The lift of the balloon is also affected by changes of temperature of the surrounding air, changes in barometer pressure, and moisture in the air; but these being so small compared with the changes brought about by the direct rays of the sun they may be ignored in ordinary ballooning. Heavy rain naturally reduces the lift of a balloon by adding considerable weight to the envelope and net, and the drying of these gives an additional lift which can not be ignored.

A bright, sunny day is generally unfavorable for making a long voyage, but alternate clouds and sunshine cause even greater disturbances in equilibrium. Assume a day with no clouds in the sky. There is still a quantity of haze which prevents the maximum heat of the rays of the sun striking the earth's surface. As the balloon rises the light-blue sky gradually becomes darker, until it assumes a deep violet color. This indicates the penetration of the balloon through haze or mist, which although not apparent on the ground is readily recognized as altitude is gained, owing to the deepening in color of the sky.

Obviously, the rays of the sun, being less obstructed, increase in power, and being intercepted by the balloon envelope this becomes heated and, owing to its large surface, quickly transmits heat to the gas contained within it. This expansion of the gas due to the heat of the sun's rays continues progressively as the balloon rises, and the gradual increase in heat of the gas may cause the balloon to continue its upward course until the approach of sunset, when the power of the sun's rays striking diagonally through a larger quantity of atmosphere lessens the heat of the rays and permits the gas to contract.

If during the time the balloon is in the sunshine a descent be permitted, which can easily occur owing to overshooting the point of eqilibrium or to some trifling change in temperature, then as the balloon descends the descending force becomes increased owing to the continued shrinkage of the gas, due to the cooling of the fabric of the envelope as it enters atmosphere protected more and more from the rays of the sun. If a considerable descent be permitted, then a very large quantity of ballast is required in order to check the descent, and if sufficient ballast be discharged to stop the descent and cause an ascent to commence the balloon again enters rays of the sun of increasing heat, and it will continue to accelerate in its rise up to the altitude which it attained on the previous ascent, and when it arrives at its point of equilibrium it will overshoot that point a distance proportionate to the speed of ascent attained.

EFFECT OF CLOUDS.

Take, for example, an ordinary atmospheric condition, when a layer of clouds floats with its lower portion at, say, 3,000 feet altitude and the upper portion at, say, 5,000 feet.

If a balloon be permitted to rise and penetrate the layer of clouds, ascending into the sunshine above them, considerable expansion of gas will occur, and the balloon

will remain above the clouds for an hour or more unless brought down earlier by opening the valve to permit of the escape of some of the gas.

On descending the descent may be made slowly until the clouds are reached, and as soon as the balloon enters the clouds and the sun becomes obscured the gas contracts and increases the descending force, and this descending force accumulates until counteracted by the discharge of ballast.

The balloon breaking through the lower portion of the clouds brings the earth into view, and a considerable quantity of ballast will have to be discharged to compensate for the contraction of the gas reducing its displacement, and also a small additional portion to give the balloon a margin of lift beyond the point of eqilibrium. This additional portion of ballast to be discharged will depend on the amount of momentum attained by the balloon in the descent and the rate of cooling of the gas.

If the pilot waits until he is near the ground before discharging ballast, then the additional amount to be thrown will be very much larger than if he checks his descent by discharging ballast gradually as the gas contracts.

On a day when such a layer of clouds exists considerable gas may often be saved by opening the valve and allowing a portion of the gas to escape, sufficient to prevent the balloon breaking through into the sunshine above the clouds. It is not too late to open the valve after passing through into the sunshine and descending into the clouds before the envelope has collected much heat from the sun's rays.

BAROGRAPH CHARTS ILLUSTRATING ASCENTS.

The barograph keeps a mechanical record of all the incidents of a balloon voyage. The two following charts show examples of ascents:

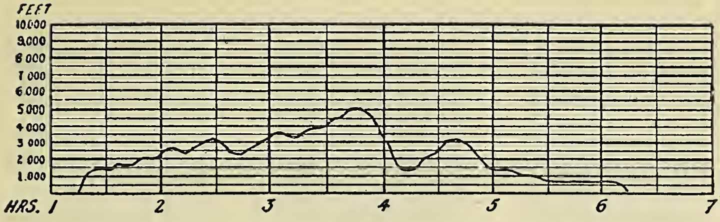

FIG. 10.—The above illustrates a typical day ascent, showing the disturbance in equilibrium due to the sun.

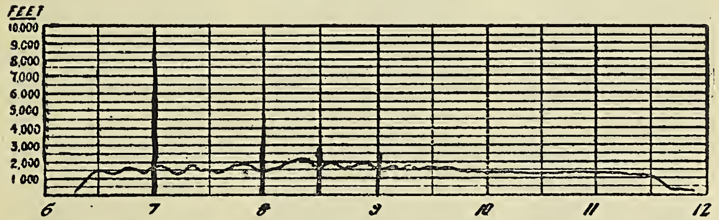

FIG. 11.—The above illustrates a typical night ascent, showing the equilibrium obtainable at night.

The three chart-sections reprinted from "The Field" are the record of the 80,000 cubic foot balloon "Britannia" in the Gordon Bennett race from Berlin, when Flight Commander McClean was my aide, and illustrate how vertical currents prevented equilibrium being attained during the early part of the night, but how when these currents ceased after midnight fair equilibrium was attained. Then when the sun came out the gas became warmed and carried the balloon on a gradual incline up to 8,500 feet at 9.40 a. m., this altitude being fairly maintained until nearly 2 p. m. by careful use of ballast. From 2 to 5.30 p. m. the balloon was slowly checked down, until at 6 p. m. too much ballast was thrown, and the valve had to be used to prevent a run up to 8,000 feet. This upward run was stopped at 4,000 feet, and the balloon gradually descended for one hour, when too much ballast was thrown again, and the valve was opened. A more gradual descent was then made, and at 8.40 p. m. the valve was finally opened and a landing made near Bremen 29 hours after leaving Berlin.

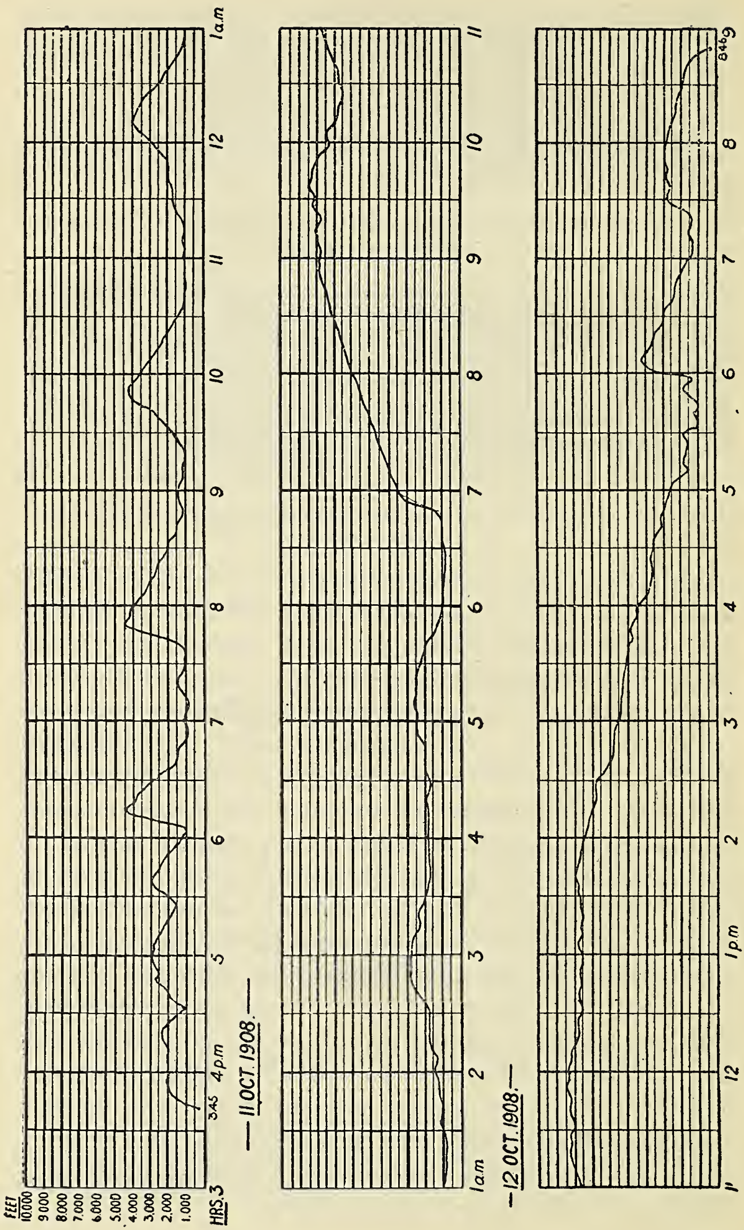

FIG. 12.—Barograph chart (reprinted from "The Field," Oct. 31, 1908).

SECOND LECTURE.

THE TRAIL ROPE.

For the purpose of economizing ballast and to aid in controlling a balloon during the landing, free balloons are provided with a trail rope. This rope is generally about 300 feet long and varies in weight according to the size of the balloon. A trail rope of about 60 pounds is generally used on balloons of 50,000 cubic feet.

The effect of a long rope hanging from the hoop is to permit the weight of that portion of the rope which is received on the ground to be taken temporarily off the balloon and is equivalent to the temporary discharge of a similar amount of ballast. Say half the trail rope comes onto the ground, the effect is similar to the discharge of 30 pounds of ballast during the descent between the altitudes of 300 feet and 150 feet. If this 30 pounds temporary discharge of ballast be unnecessary, except for the purpose of checking the remainder of the momentum, then the momentum once checked the balloon will lift the trail rope up and so pick up this 30 pounds discharge of temporary ballast. Its ascent after lifting the trail rope will be slower than if a trail rope had not been used and 30 pounds of ballast had been discharged and lost.

The trail rope also has the effect of acting as a drag on the ground when the balloon is brought down close to the ground prior to the landing being effected, the friction between the rope and the ground taking a portion of the speed of travel off the balloon and making the landing easier than it would otherwise be.

The trail rope, however, is not an unmixed blessing, because when once it is lowered it is almost impossible to pull it up into the car again. It therefore hangs permanently after once being lowered, and it may catch on trees or houses and do considerable damage. There is also the possibility of it getting permanently caught in a tree, and thus suddenly converting the free balloon into a captive balloon, when a descent must be made at the end of the trail rope; or if the ground below be unsuitable, then the rope must be cut adrift.

By twisting the trail rope in the form of a ball which unravels as it falls, one end being attached to the hoop, it may be kept attached outside the car until the landing is about to be made, when, on a retaining cord being cast, the coiled rope descends without jar. If the rope be kept up in this way, a string 100 feet in length with a piece of rope on the end may be hung from the car to indicate the distance to the ground when the balloon is low down and to serve as a sighting line below the car for locating the position vertically below.

DANGER OF REMAINING ABOVE CLOUDS.

In a little country like England, surrounded by the sea, one of the chief risks run by the balloonist is that of being carried out to sea. During the war this risk entails far more serious consequences because of the possibility of being carried to an enemy country, or by diverting the attention of a British war vessel from its ordinary duties in the attempt to be of service.

It is therefore most important that no risk of being carried out to sea should be taken. In order to safeguard against this danger, the following two rules should invariably be observed:

(1) In approaching the coast make the landing before arriving within 5 miles of the sea.

(2) Do not remain above clouds out of sight of land for more than half an hour unless you are confident of your position being well inland.

It is quite common for novices to penetrate through the clouds and remain basking in the sunshine for an hour or more; then, on coming down, some have found themselves quite close to the sea. Taking such a risk is inexcusable and should be sufficient for refusal of a pilot's certificate.

A balloon rising from London with a west wind may, with little more than a 20-mile run, be over Sea Reach; and if the wind is steady, as most west winds are, nothing but the open North Sea is in front of the balloon. Obviously, therefore, in a due west wind the pilot should be continually on the alert to see that he is not carried so far down the Thames as the distance to Sea Reach.

I have made ascents from London in west winds and gone into the clouds and above the clouds, and yet have been able to remain up longer than half an hour out of sight of the ground. This has been safely done by assuring myself of the position of the balloon by the sound of steamers in the Thames to the north. The steamer whistles were proof that, although the wind was west on the ground below the clouds, it was northwest above the clouds, and so it became possible to remain in the sunshine for an hour and a half instead of landing close to London. On other occasions, having penetrated the clouds with an east wind, and having satisfied myself that London remained to the eastward, owing to the direction of the sounds of the traffic remaining to the east, it has been possible to remain above the clouds for two hours without danger. Not only can one assure oneself of the direction of London, but one can gauge the speed of the upper wind by the length of time taken for the sounds to disappear. It is a fairly safe rule to anticipate a stronger wind above than near the ground, and one must not assume that the balloon will only continue to travel at the speed with which it starts.

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BOUNCING ON CLOUDS.

On penetrating a layer of clouds and rising into the sunshine a balloon increases its speed of ascent due to expansion of the gas by the heat of the sun's rays on the envelope. After rising perhaps a further altitude of 3,000 feet and wasting gas, at the end of an hour or so a descent is commenced; and if this is slow, the balloon will approach close down to the clouds and then commence to rise, or perhaps come to rest on the cloud surface. This bouncing off or sitting on the clouds is probably caused by the radiation from the cloud surface heating the under portion of the balloon, and thus additional heat is imparted to the gas, which expands and causes a new rise or restrains the descent.

BALLOONING AT NIGHT.

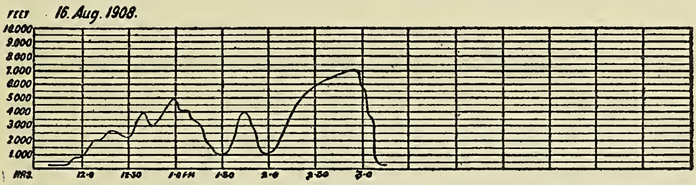
The navigation of a balloon at night is far easier than the navigation of a balloon during the day, because the temperature of the gas is not subject to the disturbing effect of alternate sunshine and cloud.

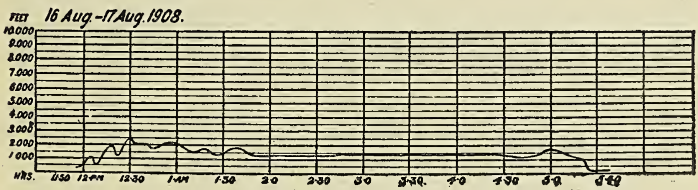
It is possible at night to attain absolute equilibrium and to remain in equilibrium without discharge of ballast for a considerable time. This economy in gas and ballast explains why long-distance balloon races, such as the Gordon Bennett balloon races, always commence in the afternoon, an hour or so before sunset. In October a balloon can rise at 5 o'clock, and if she rises gradually the sun sets before she has attained an altitude of more than perhaps 2,000 feet. In fine weather this altitude can then be maintained throughout the night, and it is not until the sun comes out in the morning and warms up the envelope, thus causing the gas to expand, that a greater altitude need be attained.

By careful manipulation of ballast the rise which commences in the morning can be gradually continued until

sunset, probably ending the day at an altitude of 9,000 feet. The balloon can then be brought down slowly by the gradual discharge of ballast preventing it attaining a high speed of decent, and equilibrium may be attained for a second night at a similar altitude to that of the previous night. In fact, by judicious use of ballast the altitude of the night ascent can be fixed; this is always assuming that the air is not in a boiling state with upward currents, such as occurs in thundery weather.

Although the gas in a balloon changes its volume in proportion to the increase or decrease of atmospheric



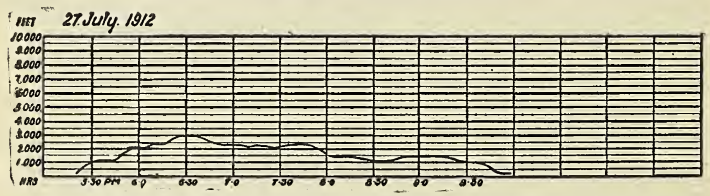


pressure, the material forming the car, ballast, passengers, fabric, net, ropes, etc., do not expand and contract. These materials may have a cubic capacity of, say, 50 cubic feet, which in a 50,000 cubic-foot balloon represents one one-thousandth of the total displacement of the balloon. In rising, therefore, this 50 cubic feet displacement displaces less weight of air, and in descending displaces more weight of air, and this comparatively small fixed displacement conduces to a small degree in maintaining a constant altitude. By day this stabilizing effect is not apparent, because of the great disturbances in lift which are continually occurring; but at night,

when the temperature settles down to an invariable constant inside and outside the balloon, this unaltering displacement is sufficient to appreciably contribute to the attainment of absolute equilibrium. After once the balloon has been brought to a state of equilibrium by the careful manipulation of ballast during the early part of the night it may be possible to travel for hours without discharging ballast.

GAS CLOUD IN BALLOON.

On one ascent at sunset, the gas in the balloon became a cloud which obscured the view of the valve through the appendix. The following morning a crackling noise was



heard above the car, and later water began to drip from the appendix.

Evidently the gas was humid when let into the balloon, the chill of the night condensed it into a cloud, this condensed into rain on the inside lower half of the balloon, the water froze, the ice field broke up under the influence of the sun in the morning, making a crackling noise in doing so, and then, the ice melting, the water dripped from the appendix.

LANDING.

There are two recognized methods of landing:

1. By valve and grapnel.
2. By valve and ripping.

The first of these methods was the only one in use 20 years ago, and is still the best method under easy conditions.

The second is one best adopted in very high winds.

In both methods the approach to the ground is the same, viz, the speed of descent should be checked before arriving within 500 feet in order to enable the landing spot to be chosen so as to avoid trees or other obstructions likely to damage the balloon. If the country is much wooded or populated, the landing place should be carefully waited for and a good lookout be kept ahead for open spaces likely to be of use. When a suitable place is observed ahead, the balloon may be brought gradually down, and so far as the safety of the balloon is concerned the speed of descent can be regulated sufficiently to cross rough country or trees, and the trail rope may drag on the trees behind. If the grapnel is thrown, the relief of about 50 pounds of weight permits the balloon after the first ground contact to rise to the length of the grapnel rope, and this lift is known as "kiting," because of the erroneous general impression that it is due to the wind, the relief of weight of the thrown grapnel being often overlooked. Whether the rip panel be pulled or not, it is well to keep the valve open; and in effecting a landing the valve line should be threaded through one of the loops on the car so as to keep an even pull on the valve when once it has been finally opened. The complete deflation can be effected in this way, and if there is any urgency for deflating the balloon quickly the rip panel may be pulled out. It is best to use the rip panel as seldom as possible, because each time the panel has to be sewn in new rows of stitches have to be made in the panel and in the panel frame.

There is a widespread belief that the jar of the car coming into contact with the ground can be relieved by the passengers holding onto the car ropes and taking

their weight off their legs. This results, if tried, in considerable danger of being drawn out of the car and the risk of being badly hurt.

Passengers in balloons should never get out of the car when landing until told to do so by the pilot. This is a cardinal rule, which if broken may have fatal consequences to the other occupants of the balloon. There have been several instances of loss of life in rough descents owing to one or more of the passengers leaving the car before the balloon came permanently to rest.

When landing in a high wind, the rip panel should be pulled out immediately on contact of the car with the ground. It is safest not to throw the grapnel on such occasions, because if a little delay occurs in "pulling out the rip," the relief of the grapnel may let the balloon up till the car is 30 or 40 feet above the ground, and then the gas, becoming suddenly released, the car may fall with considerable shock.

TEMPORARY LANDING.

In making a temporary landing, no one should leave the car until a weight at least as heavy as that of the person alighting be taken into the car. In no case should the holding on by persons outside the car be relied on. If no people are available and if the wind is very light, weight may be dug up from the ground outside the car by one of the party sitting outside the car in a rope loop. In a wind more gas will have to be discharged and the grapnel must be thrown.

HIGH ALTITUDE ASCENTS.

For crossing mountains or for observation, the object of some particular balloon journey may necessitate attaining a high altitude.

Suppose it is necessary to take a balloon to an altitude of 11,000 feet within half an hour of leaving the ground.

At that altitude a full balloon on the ground will lose about a third of its gas in rising; consequently, if the balloon be completely full to begin with, it must either start its ascent with a very big lift and run up at a great speed or ballast must be continually discharged during the ascent. In both cases gas will overflow through the appendix all the way up.

The usual method therefore adopted when a high altitude is to be attained is to partly fill the balloon, say two-thirds full, and then rise with a lift of, say, two or three bags of ballast. The piloting is then considerably simplified, and the balloon rises at a moderate speed without losing gas, the lower disinflated portion of the balloon gradually filling as the atmospheric pressure decreases, until at the predetermined altitude the balloon becomes completely distended and the gas overflows moderately through the appendix.

THUNDER DISTURBANCES.

Up to the present we have considered the piloting of a balloon under ordinary conditions and when disturbed by changes in temperature only. Thundery conditions introduce a further complication due to rising currents of air.

You have no doubt observed how a thunderstorm comes up against the wind. This generally means that the wind is blowing in varying directions at different altitudes and that the wind on the ground may be traveling in the opposite direction to the main current carrying the storm. Quite apart from the changes in horizontal direction, the air during thundery conditions is further complicated by the existence of violent upward currents.

Sometimes this complex mixture of air currents is found close to the ground. Sometimes the disturbance does not commence until perhaps above an altitude of 2,000 or 3,000 feet, and then it may be possible to keep below the storm area.

If the pilot has the choice, it is best not to make ascents during thundery conditions, not from any danger of being struck by lightning, but because the balloon will be carried violently upward and downward, and even when provided with ample margin of ballast it may be beaten down to the ground.

Do not hesitate if caught in a thunderstorm to use the valve, because if the valve be left closed for fear of making a path for the lightning, the gas will flow out through the appendix when the balloon is lifted and still make a similar path. There are only two instances on record of free balloons in Europe having been struck by lightning, although there have been hundreds of ascents when balloons have been caught in thunderstorms.

In addition to being beaten down by wind, heavy rain may be encountered which can in a few minutes add over 100 pounds weight to the top of the balloon. When a balloon is beaten down in a thunderstorm a pilot should be prepared for a rough landing, because a thunder-squall on the ground is often very violent.

SHRINKAGE AND EXPANSION OF NET.

When a balloon is inflated in the wet the net naturally shrinks, and if it be very wet you will observe that the hoop is drawn up close to the appendix. On making the ascent after rain the balloon may rise into the sunshine, where the net will dry. As the net dries it recovers its original size and in expanding it slips over the envelope, moving downward in little jerks. The first time one experiences this dropping of the car a feeling of alarm naturally arises, and so it is well to be prepared for this unpleasant phenomenon.

VALVE OUT OF ORDER.

I have been asked what to do if the valve does not work. The answer is, "Do nothing." If the balloon is

left to itself it will ascend until sufficient gas has escaped by the appendix, and it will then descend naturally until, when the car is on the ground, the rip panel may be pulled out. One can, however, always assure oneself that the valve will work by opening it before leaving the ground.

PARACHUTING BALLOONS.

There is a rope, attached by four small lines to the mouth of the balloon, which is known as the neck line. This line is allowed to hang loosely with a single bend round a car line when the balloon is in the air, and just prior to landing, if the wind is at all strong, this rope should be attached to the hoop or to a car line. The object of attaching the neck line is to hold the neck of the balloon down to the hoop and prevent the balloon parachuting and dragging the car across country when landing.

The reason this line is left free during the ascent is because, in the few instances when the envelope has burst or been torn in the air, the lower part of the balloon may be permitted to rise inverted into the upper part as the gas escapes and thus convert the baloon into a parachute. In two cases where I have observed this take place, the parachuting effect has operated satisfactorily, and in two others described to me by Mr. Mortimer Singer and Mr. Eustace Short, who were present in the two parachuting balloons, their lives depended on the success of this transformation.

It must not be assumed, however, that such accidents are at all frequent, because balloons can not burst if the appendix is open, and it is assuring to recollect that a balloon is subjected prior to each ascent to a handling on the ground far more severe than it will ever receive in the air. Every mesh of the net is tested automatically by the sand bags and by the wind, so if the balloon stands

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the test of inflation it will not fail you when once it is free and floating in the air.

ATTITUDE OF PILOT AND PASSENGERS WHEN LANDING.

When the car is about to strike the ground, all occupants should bend their knees in order to take any shock of rapid descent elastically. Each person should use his hands to hold on to the side of the car or to the lower portions of the car lines, merely to steady himself but not to take any weight. The practice of attempting to hang on to the car lines when landing is extremely bad, being both useless for the purpose and dangerous. If the balloon is descending very quickly, the car lines descend with the falling balloon and the passengers hanging on to the car lines will also descend at the same speed and be dropped on the bottom of the car without relieving any of the shock.

Immediately afterwards the balloon rebounds, tightening the car lines, and then, if the passengers continue to hold on firmly, they are pulled suddenly up from the bottom of the car and are extremely liable to be thrown out of the car altogether.

The easiest way and the safest to take all landing shocks is by keeping the knees bent, in the same manner that you would if jumping off a table onto the ground.

FALSE LIFT AT STARTING.

A false lift is often experienced when a balloon leaves the starting ground. On the completion of the inflation the neck of the balloon is tied up with a slipknot. The leading lines from the net are then allowed to converge, pressing on the underside of the balloon, which they tend to flatten, but they are supported by the resistance to compression of the gas. The balloon is then weighed up with the neck tied, and on equilibrium being attained an

additional bag of ballast is taken out in order to insure a quick rise. A lull in the wind is waited for, and then the slipknot is pulled off the mouth of the balloon, and a few seconds later the balloon is let go. If the lower sides of the balloon have been maintained in spherical form by the confined gas, on the opening of the mouth a comparatively large volume of gas is forced out by the straightening of the leading lines of the net, and in a very few seconds the lifting effect equal to a bag or more of ballast is lost. This entails a false lift, and a balloon frequently released with an apparently good lift is seen to descend after reaching an altitude of perhaps 100 feet or less, and a quick discharge of ballast is the only way to save contact with adjacent buildings. On a windy day this trouble arises more frequently than on a calm day, because the pilot is reluctant to open the neck much before letting go for fear of losing gas.

Opening the neck half a minute before finally weighing up may save considerable subsequent waste of ballast, which has to be suddenly thrown after the balloon has commenced to fall, in order to clear trees or houses at the boundary of the starting field.

LOG KEEPING.

On one or two occasions novices have complained of the difficulty of keeping a log and at the same time attending to all the duties necessary in a solo ascent. The log should be written up during the times the balloon is ascending, but immediately a descent commences you should disregard the log entirely and give all your attention to piloting the balloon. In this way you will find plenty of time to make the necessary notes and yet attend to all the pilot's duties without becoming flurried. Always keep your position on the map and prevent the balloon gathering high speed in descending, even at the cost of neglecting to keep the log properly.

DIRIGIBLES IN EQUILIBRIUM MOVE WITH EQUAL SPEED IN ALL DIRECTIONS.

If a dirigible be capable of moving under power at 50 miles per hour, it can move at that speed horizontally or on an incline, providing it be in equilibrium. If it be light, then it can rise on an incline at more than 50 miles per hour; and if heavy, then it will rise at a slower rate, the reduction in speed being caused by a portion of the power being used for support instead of for propulsion.

After a dirigible has discharged weight and become light she can rise very fast, possibly 3,000 feet per minute, so this explains the difficulty in attacking a Zeppelin by aeroplanes having a maximum climbing speed less than 1,000 feet per minute, unless they are already high in the air when the Zeppelin arrives.

DIRIGIBLES NOT UNDER POWER ARE FREE BALLOONS.

Dirigibles attain the altitude they desire under power and not by use of valve and ballast. Once a dirigible is deprived of her power, she becomes subject to all the conditions regulating the flight of a spherical balloon. She is, however, more cumbersome and difficult to handle. In the event of an engine breakdown, therefore, all the skill of the balloonist is brought into play, and it is only by careful manipulation of the gas and ballast that a safe landing can then be made.

THIRD LECTURE.

BALLOON INSTRUMENTS.

1. Maps.
2. Compass.
3. Aneroid.
4. Barograph.
5. Statoscope (Richard).
6. Bubble statoscope.
7. Air-speed indicator.

1. *Maps.*—In free ballooning the map is the most important instrument. Without a map a balloon trip develops into a voyage of exploration in which the pilot must be prepared for a continued unfolding of the unknown. The duty of the observer who has charge of the map is to keep the course of the balloon without losing his position at any time. Once the position is lost, the difficulty of identifying the position afterwards may be very great.

The time of starting should be carefully noted, a useful method of doing this being to start a stop watch immediately on leaving the ground. Then identify a spot, say, 15 minutes after leaving, and mark this position and the time on the map. This gives the speed of travel and the direction, and, later, as the balloon rises to higher altitudes, you will be able either to confirm the speed and direction or note the change. If the trail rope is lowered, watch the end of the rope to locate the position of the balloon.

Where two pilots are in a balloon the duties are generally divided, one controlling the gas and ballast, the

other keeping a close watch on the map, and this latter duty is often the more difficult and important of the two. In piloting or controlling the balloon, the pilot is aided by several useful instruments, but none of these is indispensable.

2. *The compass.*—There is no need for me to give you directions for the use of the compass, because you have already gone fully into this valuable instrument in the other lectures. I must, however, impress the importance of taking a compass bearing of the starting ground from the balloon soon after leaving in case of the balloon entering clouds before the direction of travel has been accurately taken. In case no compass is available, several substitutes are at your disposal.

During the daytime, if the sun is in sight, the south can be located by turning your watch to the position where the hour hand points toward the sun, and then the position midway between the hour hand and the 12 is due south. At night the North Star is a useful check on the compass, and at all times the position on the map and observation of a known direction of travel are the best of guides.

Out of sight of the earth the compass and the sun are generally no guide to the direction of drifting of a free balloon, although occasionally, by observing the relative direction of travel of clouds, information may be gathered of change in direction of drifting of the balloon.

The compass is useful for picking up the position on coming into sight of the ground from the clouds, and it becomes indispensable if the course takes you off the limits of your large-scale maps.

3. *The aneroid barometer.*—This is merely a delicate pressure gauge, the hand moving over a scale graduated in feet or meters of altitude. At sea level the atmosphere is normally at a pressure of 30 inches of mercury, or about 15 pounds to the square inch.

As the balloon rises to greater altitudes the atmospheric pressure diminishes, owing to the fact that less weight of air is contained in the atmosphere above, and therefore presses on the surrounding atmosphere with

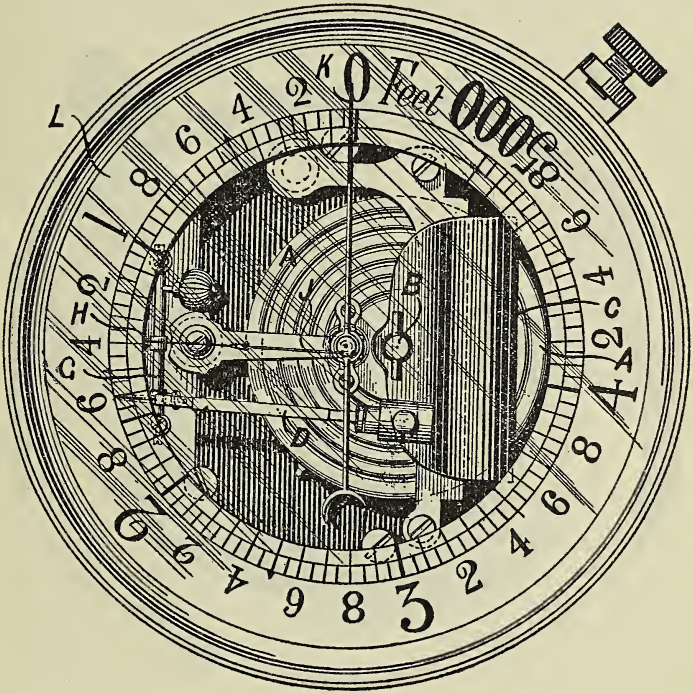


FIG. A.—Aneroid barometer. Face view.

A. Elastic vacuum box.
B. Connecting rod.
C. Spring.
D. Arm fastened at its base to spring C.
E. Connecting link.
F. Arm to rocking shaft.
G. Rocking shaft.
H. Arm from rocking shaft.
J. Flexible chain to hand spindle.
K. Hand on spindle.
L. Dial calibrated in feet.

less force. This diminishing atmospheric pressure permits the sealed chamber in the aneroid to expand, and the movement of the corrugated disc of the sealed chamber is

communicated to the indicating hand by means of gearing. As the balloon descends the atmospheric pressure on the sealed chamber of the aneroid increases, causing the reverse movement to take place until the balloon again comes to earth, at sea level, for example.

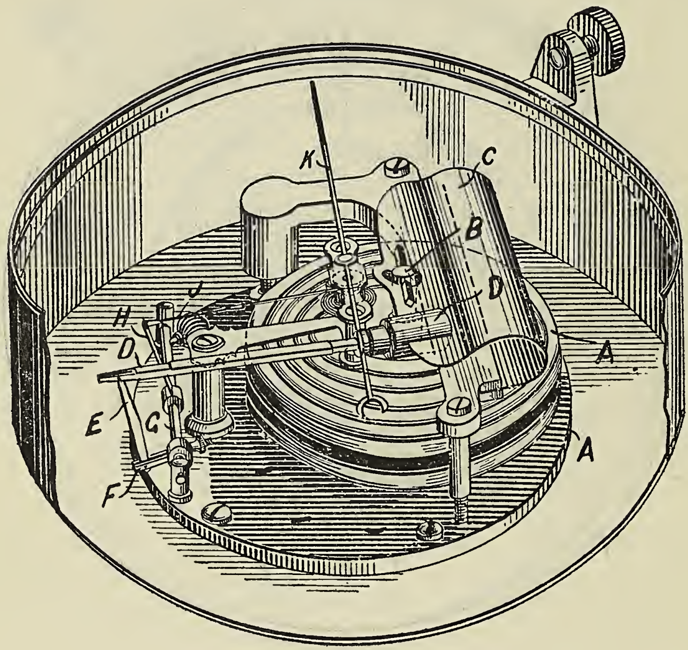


Fig. B.—Aneroid barometer. Interior section.

N. B.—Changes in atmospheric pressure due to changes in weather conditions alter the initial zero position of the hand. The dial L is therefore adjustable in an angular direction to right or left so as to enable the pilot to set his aneroid to zero before starting. If the height above sea level of the starting ground be known, this should be allowed for when setting the hand.

You would naturally expect if the balloon originally made an ascent from sea level that when it came back to sea level the aneroid would return to zero. Unfortunately in all instruments where elastic resistances are

moved the recovery back to normal does not take place instantaneously, and a considerable time must elapse before the complete recovery of the hand to its original starting position. This lag or slowness in recovery is known as hysteresis, and the actual effect in an ordinary aneroid barometer (which is sometimes called an altimeter) is an error of perhaps 1 per cent to 2 per cent in recovery. Thus after making an ascent to 10,000 feet the aneroid might still indicate 100 feet or 200 feet altitude when the balloon has returned to sea level. The amount of hysteresis error in instruments depends on the elastic medium used for measuring the pressure, the length of time the instrument is under the influence of the change in pressure, and the length of time allowed in returning the instrument to the normal pressure. There is no need, however, to go into all these reasons and the quantity of effect, it being sufficient for our purpose in ordinary aeronautical work to be prepared for the aneroid reading slightly high on landing after a high flight.

4. *The barograph.*—A barograph is a registering aneroid barometer, and, although it suffers from the fact that there are more moving parts, and consequently more friction to resist accurate recording, it carries the advantage of marking continuously during the balloon voyage the changes in altitude at various times. A barograph chart is most instructive, and to the aeronaut who understands the piloting of a balloon it will tell him of his faults and recall all the incidents of the balloon journey. It is an instrument, therefore, which should be carried on all balloon ascents, and, although there is no necessity to have the barograph in sight during the ascent, space should be found for it in the instrument basket.

A. Elastic vacuum box.
B. Connecting rod.
C. Rocking lever.
D. Connecting link.
E. Arm to rocking shaft.
F. Rocking shaft.
G. Light spring extension of arm from rocking shaft.
H. Pen on spring bearing against chart on drum.
J. Chart on drum.
K. Disengaging rod.
L. Lever for operating disengaging rod K.
M. Drum rotating once in six hours.
N. Key for winding clock in drum N.

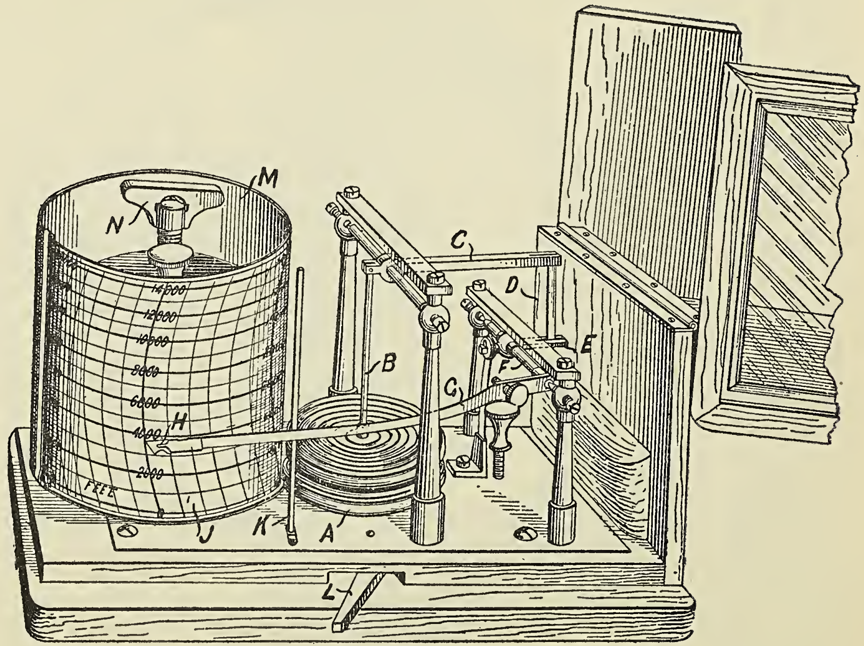
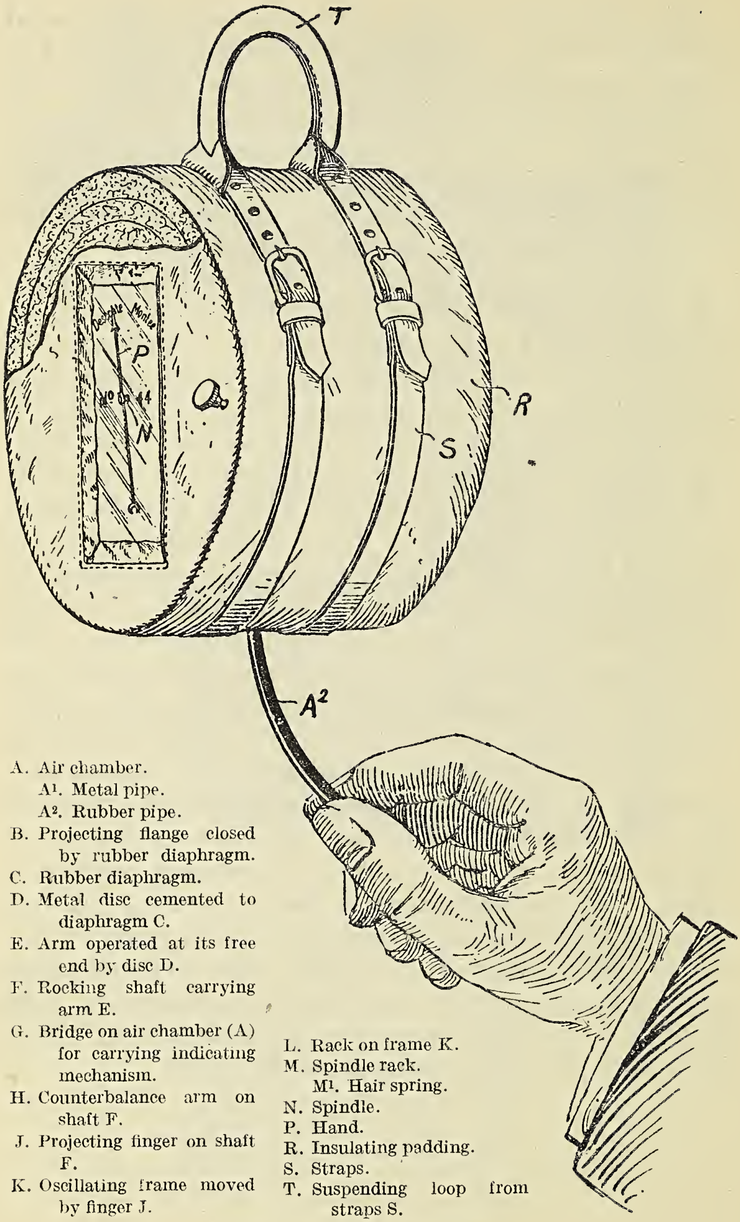


Fig. C.—Barograph. Calibrated to 14,000 feet.

On examination of the chart afterwards the time of starting from the ground can be observed, the speed of ascent can be gauged, and by noting the steepness of the undulations the pilot will recognize when he threw too much ballast or used the valve too vigorously; the actual time of landing will also be noted, together with the time on the ground before the balloon was lifted on to the cart for conveyance to the railway station.

5. *The statoscope.*—This instrument consists of a chamber having a rubber tube communicating with the atmosphere, and a further opening to the chamber is covered by an elastic diaphragm to the center of which is connected an indicating mechanism somewhat similar to a very delicate aneroid barometer movement. By pinching the end of the rubber tube the chamber becomes separated from atmospheric pressure, and the aneroid movement is therefore brought into action, with the result that the hand moves rapidly to the left if the balloon is descending and to the right if the balloon is ascending. The speed of movement of the hand indicates the speed of descent or ascent of the balloon, and with practice you will very soon recognize whether to throw much or little ballast for the purpose of reducing the speed of descent.

6. *The bubble statoscope.*—This instrument has the considerable advantage of continuously indicating whether the air craft is rising or falling, without requiring a setting operation to be performed before each reading is taken. The principle on which this instrument operates is by means of a globule or bubble of colored liquid traveling to left or right in a capillary tube and indicating whether air is entering or leaving an insulated flask. The illustrations on page 46 explain the principle on which the bubble statoscope is constructed.



A. Air chamber.
  A^1. Metal pipe.
  A^2. Rubber pipe.
B. Projecting flange closed by rubber diaphragm.
C. Rubber diaphragm.
D. Metal disc cemented to diaphragm C.
E. Arm operated at its free end by disc D.
F. Rocking shaft carrying arm E.
G. Bridge on air chamber (A) for carrying indicating mechanism.
H. Counterbalance arm on shaft F.
J. Projecting finger on shaft F.
K. Oscillating frame moved by finger J.
L. Rack on frame K.
M. Spindle rack.
  M^1. Hair spring.
N. Spindle.
P. Hand.
R. Insulating padding.
S. Straps.
T. Suspending loop from straps S.

FIG. D.—Richard's statoscope.

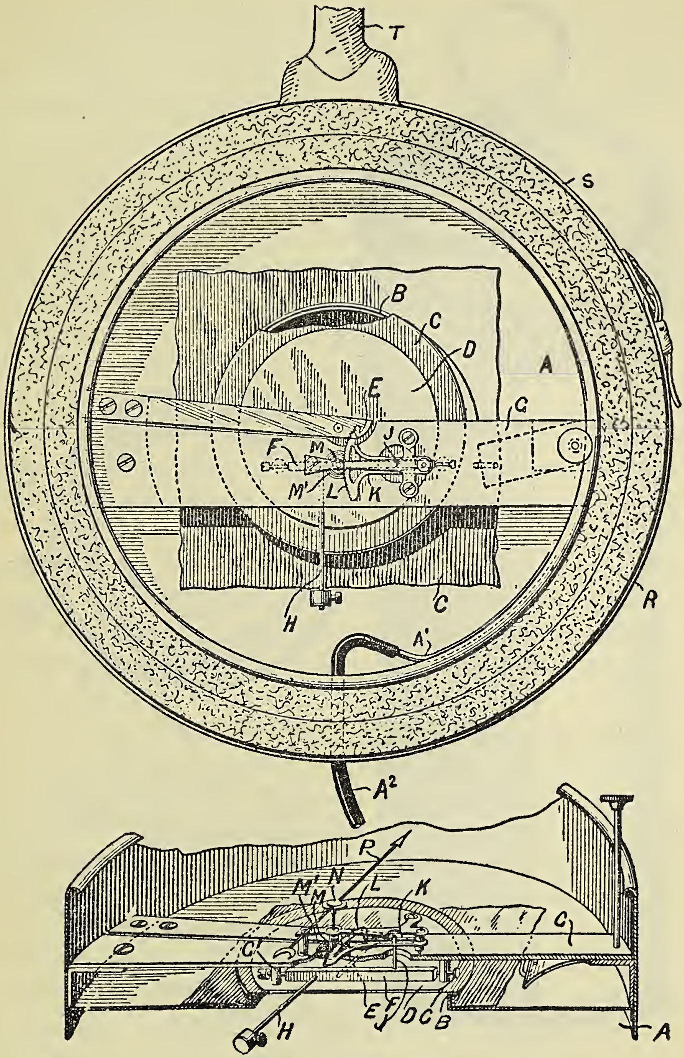
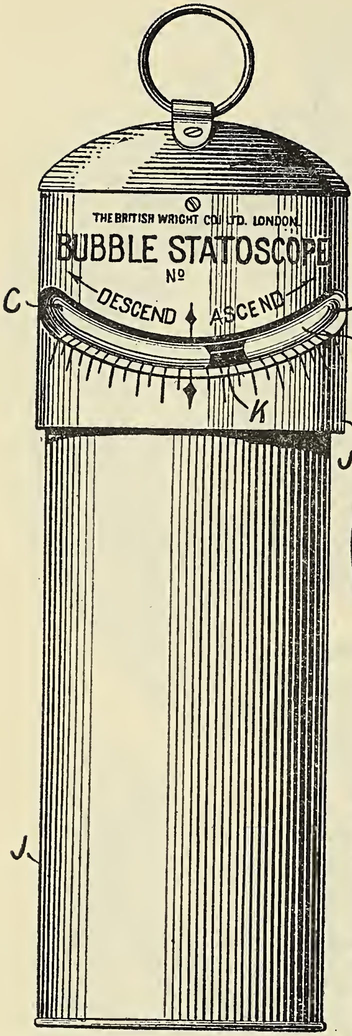
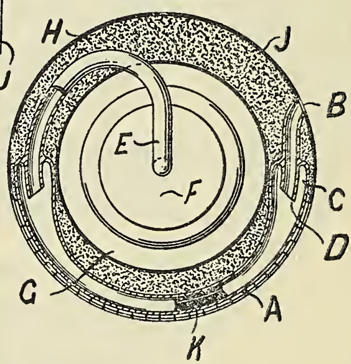


FIG. E.—Richard's statoscope. Section and interior view (below).



Elevation.

Sectional plan.



Sectional plan.

A. Capillary tube with bulbous ends.
B. End of tube open to atmosphere.
C. Bulbous enlargements.
D. Entering tube, with sharp end to break bubble as it is lifted by air flow.
E. Communicating tube to flask.
F. Rubber plug.
G. Vacuum flask.
H. Insulating material.
J. Outer casing.
K. Globule or bubble.

Fig. F.—Bubble statoscope.

All the above instruments are of interest but, as stated at the beginning of this lecture, none are indispensable except the map. Provided you have a sheet of paper, a balloon can be navigated with moderate effi-

ciency. A thin piece of paper thrown into the air serves as a point of comparison, because it falls so slowly that it may be taken as a relatively stationary object. By tearing off a piece of thin paper and throwing it over the side of the car, it will be observed that the paper will apparently drop if the balloon is rising and will apparently rise if the balloon is descending. This is not an infallible indication, because if the balloon happens to be in a quick-rising current, instead of comparing the movement of the balloon to a comparatively stationary object, the movement of the balloon is then compared to an object influenced by the upward current of air. On the majority of days, however, the upward currents are not considerable, and on many days they can be disregarded entirely, so the throwing out of tissue paper is a very efficient makeshift in the event of the pilot finding after leaving the ground that he has forgotten his aneroid barograph and statoscope. This use of paper is valuable to remember, especially in the case of breaking away in a kite balloon, when, although the observer should have an aneroid as a part of his equipment, it is possible that he may be without instruments of any kind.

7. *The air-speed indicator.*—An additional instrument which is now being used in kite ballooning is the air-speed indicator. This consists of a delicate pressure gauge connected by two tubes to a pressure head and a static pressure jacket. The pressure head is attached in such a position on the car lines that it is directed against the wind, which, communicating with one tube, operates on one side of an elastic diaphragm, the other side communicating by another tube with the static jacket on the pressure head. The speed of the wind therefore moves the diaphragm, which, being geared to the hand of the instrument, this latter moves round on a calibrated dial and indicates in miles the rate at which the wind is blowing. The yawing of the balloon will vary the reading on the instrument to some extent, but the maximum speed

indicated should be noted, because it is the maximum speed which gives the strain to which the balloon and the cable are subjected.

Wing Commander Ogilvie was the first to apply a spring-operated air-speed indicator to aeroplanes. A gravity-controlled U tube had previously been used at Farnborough for measuring the speed of aeroplanes through the air, but this was found to read incorrectly whenever the weight of the indicating fluid became urged upward or downward under the influence of sudden changes in altitude of the machine in flight.

The constructor of the first spring-operated air-speed indicator was happy in the choice of an elastic diaphragm, which, when bent into spherical form under the influence of air pressure, moves at its center a distance inversely as the square of the pressure received, and as the pressure of the wind increases directly as the square of the speed, the diaphragm is caused to draw out a silken thread and turn a spindle at a rate approximately equal to the value of the air speed. This direct relation therefore permits of an evenly calibrated dial being employed without the necessity of introducing complicated intermediate gearing.

The air-speed indicator is a useful instrument for giving the speed of the wind; but the problem of measuring low speeds from, say, 10 miles per hour to 60 miles per hour is more difficult than the measurement of the higher speeds attained by aeroplanes, and the aeronaut should therefore use his judgment in wind speed to check the readings of the instrument, and from time to time, say, every six months, the instrument should be tested to see if it has varied to any extent.

All air-speed indicators mark the speed of the air at sea level, but the measurement of the speed being dependent on the density of the air encountered, it follows that as altitude is gained the speed is underindicated. This, however, is no practical disadvantage, because on

kite balloons the air speed is mainly required to be known for the purpose of ascertaining the strains to which the balloon is being subjected, and when the indicator marks, say, 25 miles per hour, it is immaterial whether this be the actual speed at sea level or whether the speed be

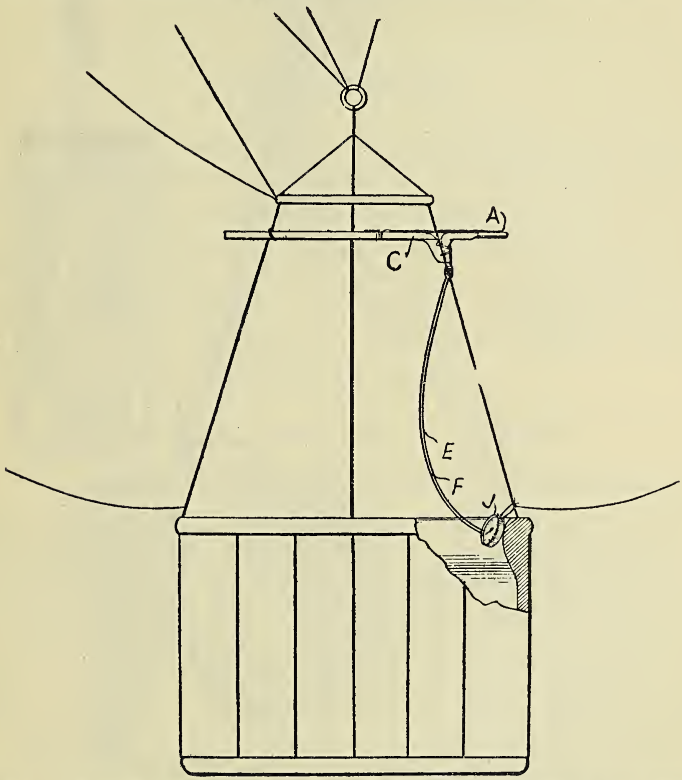


Fig. G.—Ogilvie wind-speed indicator.—Diagram showing attachment to car lines of kite balloon.

higher owing to high altitude reducing the wind pressure per mile of wind speed. Whenever the wind speed is indicated at, say, 25 miles per hour, no account need be taken of the altitude, because the pressure on the balloon is equal to that of a wind blowing at sea level at the rate of 25 miles per hour.

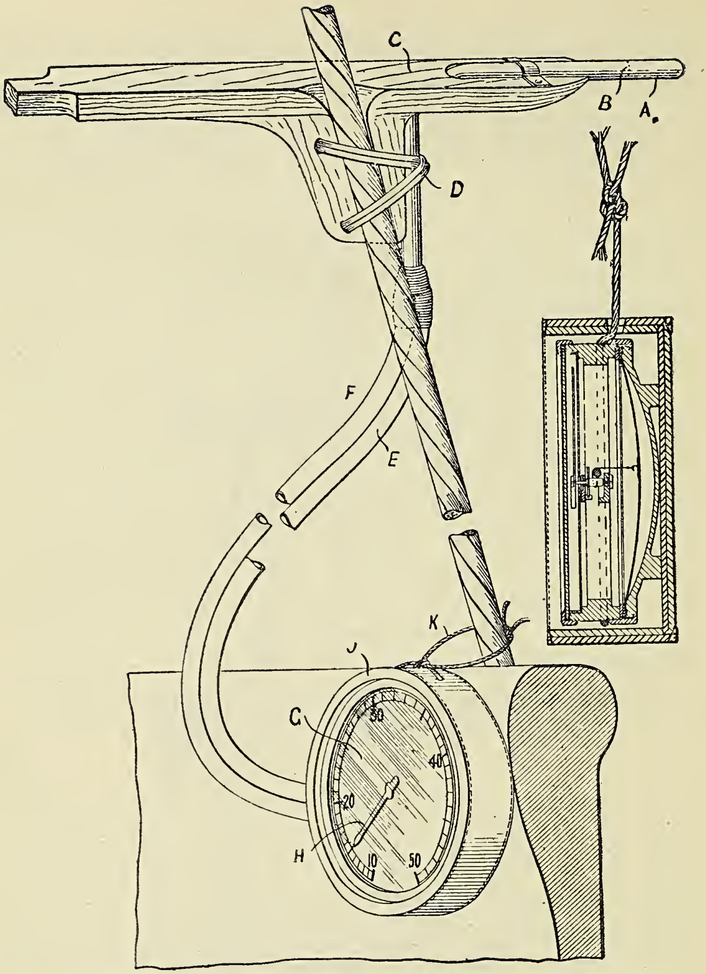


FIG. H.—Ogilvie wind-speed indicator.

A. Pitot tube with central pressure tube.
B. Holes in static jacket.
C. Holder for pitot tube A.
D. Elastic attachments for connecting to car line.
E. Flexible tube for conveying air pressure to indicator.
F. Flexible tube for conveying static pressure to opposite side of diaphragm in indicator.
G. Dial calibrated in miles per hour.
H. Hand carried on spindle turned by silk thread connected to diaphragm.
J. Leather protective case for holding indicator.
K. Cord for attaching indicator to car of kite balloon.

FOURTH LECTURE.

KITE BALLOONS.

A spherical balloon presents no problems in balance because its construction is concentric to the center of displacement lift, and the center of gravity is situated a considerable distance below. A more complicated condition arises when the gas container is of nonspherical form, and still further is the problem complicated when dynamic forces produced by kiting on a captive cable are added to the displacement force.

VERTICAL LONGITUDINAL STABILITY.

If we take a balloon of stream-line form, but without car or other attachments, it will not rise in the air horizontally as shown at figure 1, because the displacement lift varies throughout its length. It will at once be seen that the heights of the columns of gas are greater in the large portions of the balloon than in the smaller portions, and also that the amount of the

Fig. 1.

fabric employed in the construction of the more pointed end is greater in proportion to the gas inclosed than amount of fabric in the bluff nose is in proportion to the gas inclosed. This inequality in life and weight of fabric will turn the stream-line balloon from the horizontal attitude, as above, to the vertical attitude as seen

in figure 2, where the center of lift becomes vertical above the center of gravity.

A stream-line balloon released when inflated, if not controlled by other weight, will rise vertically and, like all free balloons, continue to rise until attaining equilibrium in atmosphere of diminished weight. The pressure of expansion consequent on this ascent must be relieved either by a valve or by a neck situated at the base or by leakage through the balloon fabric, and if the balloon attains equilibrium at an altitude of, say, 8,000 feet, when it descends and arrives again at sea level it will then have lost about one-quarter of its contents, and the loss will be apparent in the collapse of the lower portion of the balloon, as seen at figure 3.

Fig. 2.

Fig. 3.

An airship is restrained from assuming this vertical attitude by the weight of the car, which is suspended in such a manner as to resist the tilting of the airship away from the horizontal position. By suspending the car to several points longitudinally of the airship envelope the suspended weight becomes concentrated forward when the airship nose rises and the weight is transferred aft if the stern rises above the horizontal.

The kite balloon shown at figure 4 is lifted in the air by the weight of the air displaced and is restrained by its own weight, the weight of the car, and the pull on the cable or winch suspension. In a wind a further lifting force is added by the kiting effect of the balloon and the dynamic lift of the outstanding fins.

It is evident that this dynamic lift due to kiting will vary with the force of the wind, and consequently the angle of flight will more closely approach the horizontal

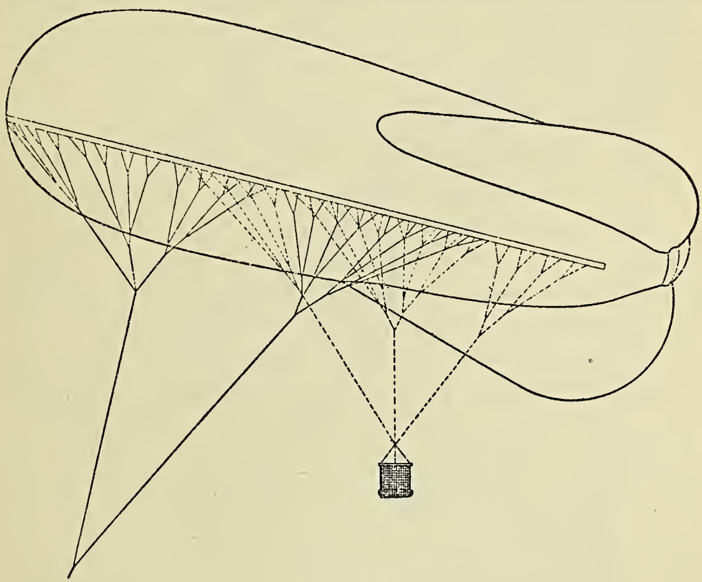


Fig. 4.

as the wind increases in force. If the cable be released, this dynamic force is removed simultaneously with the removal of the cable tension, and the balloon, no longer held down at its nose, will then turn to a steeper angle, as shown at figure 5. In this free condition the only force preventing the balloon assuming a vertical position similar to that shown in figure 2 is the weight of the car, which, being suspended by the fore and aft systems,

now concentrates its weight on the fore-car suspension and restrains the balloon from assuming an angle of more than 40° to 50°. Should a kite balloon break away and become a free balloon, the valve cord should be pulled

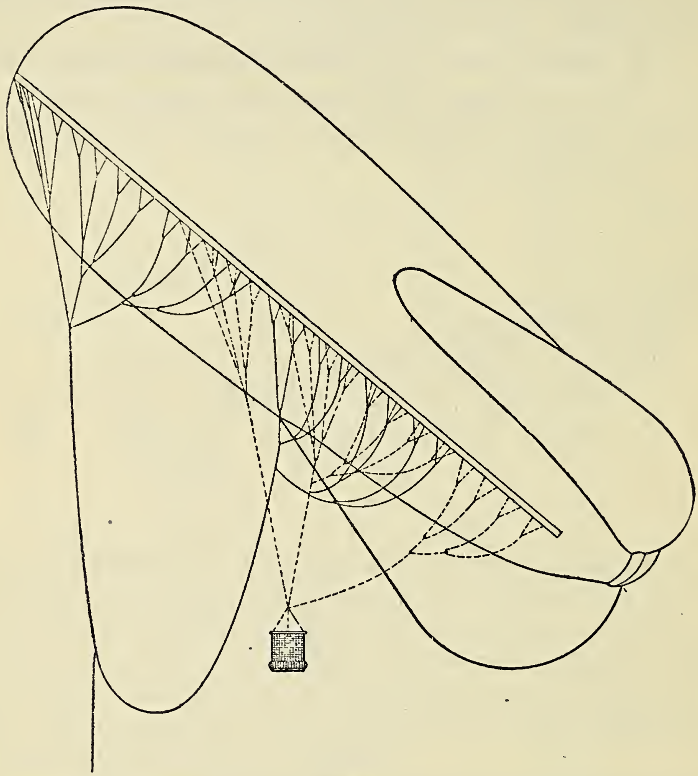


Fig. 5.

and kept open so long as the balloon continues to ascend, because, although the automatic valve should permit the excess pressure of expansion to be relieved as the balloon enters atmosphere of less pressure, the great lift will cause a rapid climb, and consequently rapid expansion of the gas, and it is safer to relieve this pressure by the use of both valves than to rely entirely on the automatic

valve. A stream-line balloon of 32,000 cubic-foot capacity with two observers and four bags of ballast may rise with a lifting force of 500 pounds or 600 pounds and may not attain equilibrium until at an altitude of perhaps 8,000 feet. More than one-quarter of the hydrogen would thus be lost in this ascent, but the balloon remaining full during the ascent will maintain the angle of repose to which it has settled soon after its release from the cable as soon as the pendulum action then set up has damped out. This initial oscillation depends on the difference in the angle of flight when on the cable and the angle of flight when free. Thus, if the angle of flight be 15° on the cable and 40° when free, the pendulum action of the car will commence from 30° on either side of the 40° angle and will slowly damp out. (Fig. 5.) This pendulum action appears violent and unsafe from the ground, but in the car is hardly felt and does not seem more than the oscillation when in a free spherical balloon on a windy day. After valving and attaining equilibrium, should a quick descent be necessary, the valve may be kept open a short time longer, but this further loss of gas may considerably accelerate the descent, and with only four bags of ballast to check the speed a considerable bump on landing should be anticipated. Ballast should be used at least 1,500 feet before reaching the ground if the speed of descent is considered too fast to be safely taken without discharge of ballast. Any ballast thrown below 300 feet of the ground will have insufficient time to take effect in much reducing the speed of ground or water contact.

During the descent from, say, 8,000 feet the balloon will gyrate, owing to the uneven shape of the tail fabric when deflated, and as the descent continues the lower portion or tail end of the balloon will become crumpled and empty, the gas remaining (fig. 6) in the nose or larger portion, slowly rising in the balloon and raising the po-

sition of the center of displacement lift. This change of the center of lift will cause the balloon to assume a steeper angle until when near the ground the balloon assumes an angle of about 80°. The whole weight of the car is then taken on the forward car suspension, the 8 attachment points on the starboard rigging band and the 8 points on the port band, dividing the strain equally between them, viz, on 16 points in all. Under no circumstances should the red rip cord be pulled until the car strikes the ground, and when descending in water it should not be pulled until a boat is at hand to take the observers from the car.

FIG. 6.

Figure 7 illustrates how the forward winch suspension and the forward car suspension both exert their force to restrain the balloon assuming a steep upward angle and continually tend to return it to its proper flying angle.

Figure 8 illustrates how the aft-winch suspension and the aft-car suspension exert their force to restrain the balloon from assuming a steep downward angle and continually tend to return it when diving to its normal flying angle.

This longitudinal stabilizing effect of the winch suspension and of the car suspension thus combine to keep the balloon in good longitudinal balance.

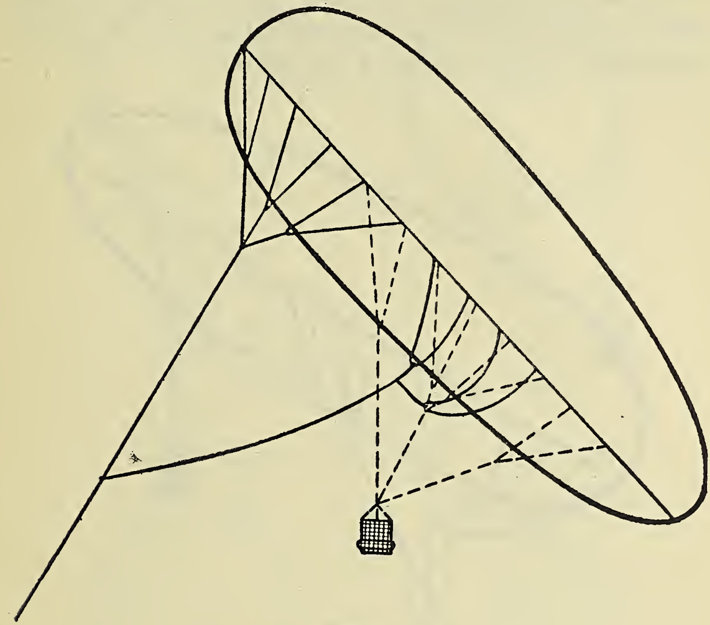


Fig. 7.

LATERAL STABILITY.

The rigging of kite balloons, being attached to rigging bands situated a short distance below the largest diameters of the balloon on both the port and starboard sides, cause the pull on the cable and the weight of the car to tend to maintain lateral stability. At figures 9 and 10 a diagram of a kite balloon in cross section is shown, in which the car-suspension lines are abnormally short. At figures 11 and 12 similar views illustrate the cross section of a kite balloon in which the car-suspension lines are longer than in figures 9 and 10. Any tendency of the balloon to

rotate on its longitudinal axis is restrained by the weight of the car, and the longer these car-suspension lines are made the earlier is the restraining effect thus produced.

The winch suspension gives a similar lateral stability effect, due also to the fact that the attachment bridles are situated on opposite sides of the balloon.

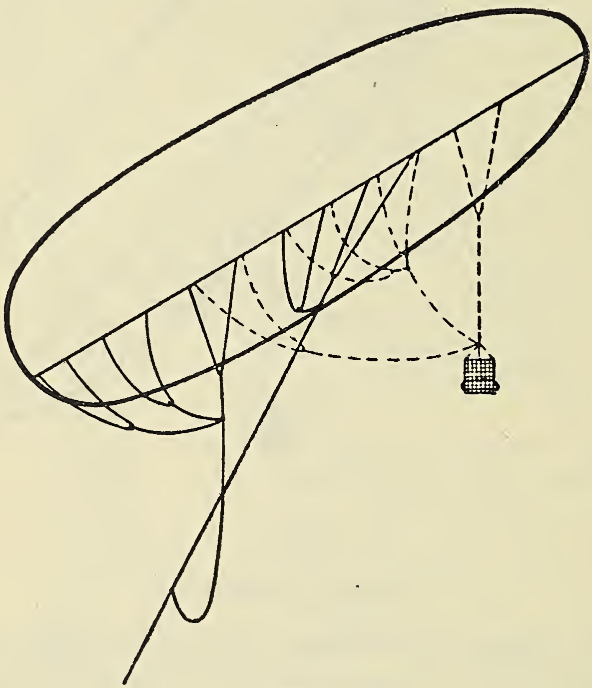


Fig. 8.

HORIZONTAL STABILITY AND YAWING.

A kite balloon is subject to a hunting movement or yawing to right and left on its cable. This is due to the fact that the winch suspension can not for obvious reasons be attached to the nose or forward point of the balloon, but must have its strain communicated to a con-

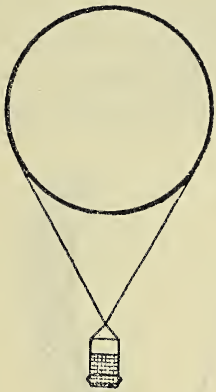


FIG. 9.

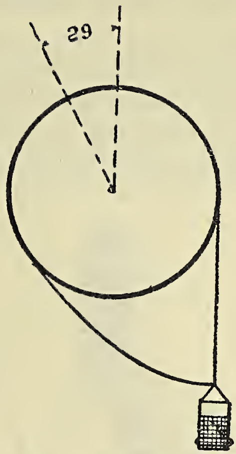


FIG. 10.

FIG. 11.

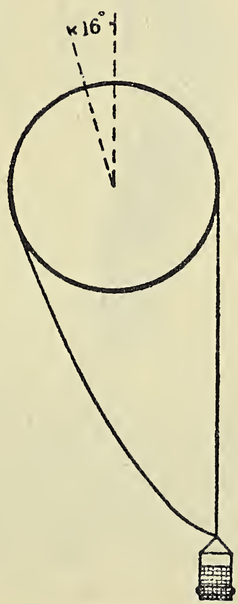


FIG. 12.

siderable portion of the forward bulk of the balloon. The farther aft it becomes necessary to place the winch suspension the greater is the tendency to yaw. An analogy to kite-balloon yawing is seen in the instances when a ferryboat is anchored to a permanent buoy by a long cable in a river and is steered to either bank by means of the rudder but utilizing the power of the stream alone.

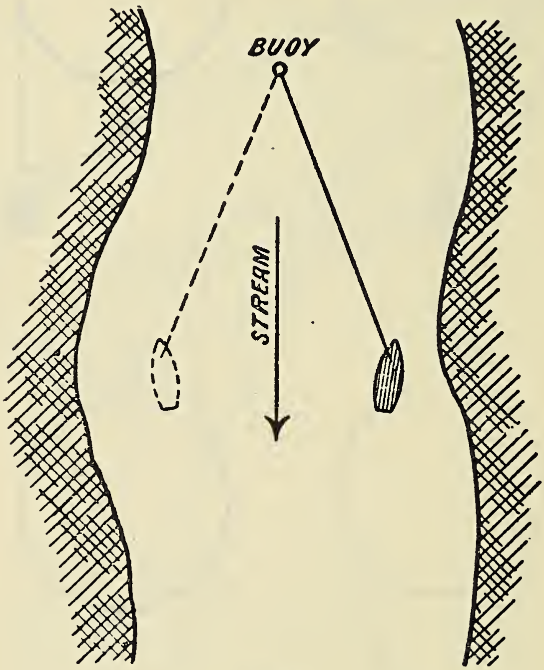


FIG. 13.

The diagram at figure 13 illustrates this ancient method of river crossing, which only requires the boat to be steered by its rudder and for the cable to be attached to a mast a suitable distance aft of the stem, to enable the boat to be directed to either bank at will. If this ferryboat were attached to the cable at the stem itself, it could not

be steered with the rudder to the same extent, because the pull on the stem would continually tend to turn the boat head to stream.

The kite balloon shown in a similar view in plan at figure 14 being unprovided with a maneuvering rudder yaws to one side until it reaches the limit of side towing angle, and then, turning on a vertical axis, presents the outer side of its nose to the wind and yaws across in the other direction until the limit of the yawing angle is reached. If no car were used on a kite balloon and it were necessary then to move the wind suspension still farther aft, the kite balloon would then take up a permanent attitude side on to the wind with the balloon set at a constant side angle, similar to a boat towed with a line attached to a thwart some distance behind the stem instead of to a painter on the stem itself. The aim of a kite-balloon designer is therefore to place the winch suspension as far forward on the balloon as is compatible with good vertical longitudinal stability, utilizing the excess weight of the fabric in the stern of the balloon and the weight of the car to balance the downward strain imparted by the cable.

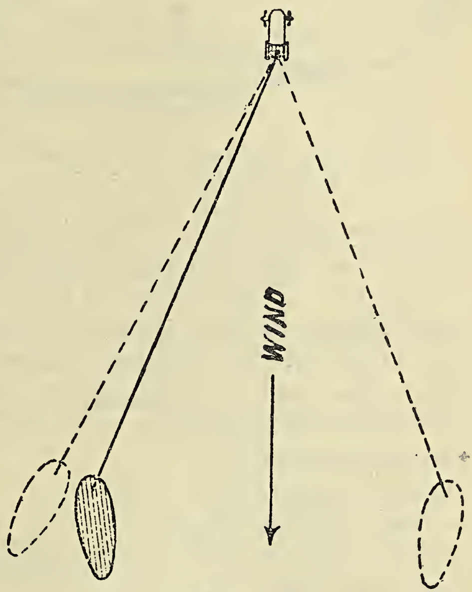


Fig. 14.

THE BALLONET.

The outer form of a kite balloon is maintained by means of a ballonet. When the balloon is completely filled with gas, the ballonet remains empty and rests against the lower aft portion of the balloon, as shown at figure 15. When leakage or contraction of gas has taken place, the ballonet partially fills with air received from the wind blowing into the ballonet scoop,

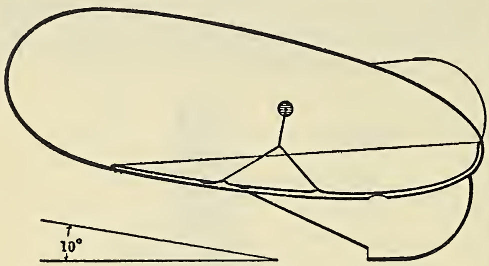


FIG. 15.

and thus the air-inflated ballonet fills up the vacant space which would otherwise have been formed in the balloon (see fig. 16). If the balloon is let up on its cable in the partly filled condition shown at figure 16, the streamline contour of the envelope is maintained by the combined gas and air inflation, and the expansion of the gas pressing on the ballonet forces the air out of the latter against the force of the air attempting to enter the wind scoop.

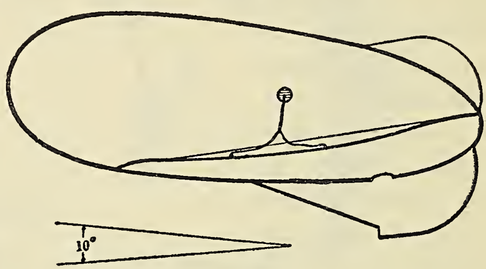


FIG. 16.

This action continues throughout the ascent on the cable until nearly all the air is expelled from the ballonet, and then the ballonet, which is attached to the automatic valve, pulls the valve open, and excess pressure is now relieved by allowing gas to escape, so

long as the ascent continues. When the cable is hauled in by the winch and the balloon descends, the ballonet inflates in proportion as the gas contracts, and this action may continue until the ballonet is completely full, as shown in figure 17; and if the balloon has been let up to such an altitude that the ballonet becomes completely inflated with air before the ground is reached, then the last portion of the descent will be made with the balloon partially deformed and flabby.

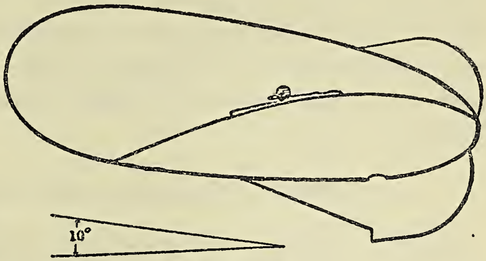


Fig. 17.

PITCHING AND SURGING OF AIR.

When the balloon is completely full of gas, and also when the ballonet is completely full of air, the diaphragm of the ballonet, which separates the gas from the air, is either held against the interior of the balloon fabric or is extended and prevented from moving relatively to the balloon. (See fig. 15 and fig. 17.) But when the ballonet is partly filled with air, as in figure 16, and this is the normal flight condition, the air in the ballonet is uncontrolled and may roll forward or aft to a position where it finds the least resistance from the gas. If the wind is unsteady, then any tendency of the balloon to pitch fore and aft may

Fig. 18.

be increased by the air in the ballonet rolling or surging fore and aft. This tendency will be recognized by reference to figures 18 and 19. In the former the position of the air in the partially filled ballonet is shown forward, thus moving the center of displacement lift slightly aft, while in figure 19, where the air has surged aft, the center of displacement lift has been moved forward, owing to the air filling the tail portion of the balloon.

CARE IN HANDLING KITE BALLOONS.

If kite balloons were as strongly built as seagoing vessels, they could be towed and moored from single points of attachment. It is necessary, however, to build them extremely light in order to enable them to float in their element (air), which is 800 times less in weight than water. Consequently, if the attempt be made to control a balloon by means of isolated attachments the connection to the balloon will break or severely strain the fabric. The strains of attachment on a balloon must therefore be distributed over large areas of the fabric and not on isolated points. The rigging of a kite balloon is designed to distribute the strain of suspension on no less than 144 points of attachment, 80 for the winch suspension and 64 for the support of the car, and although in flight the strains may be concentrated on 16 points of the winch suspension and 16 on the car suspension, some abnormal condition must arise to reduce this minimum

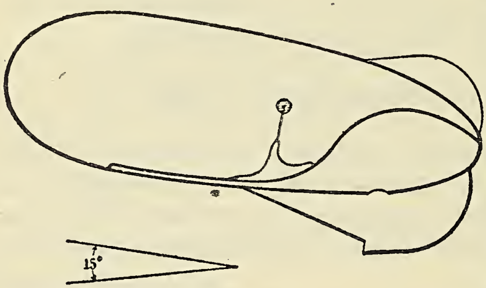


Fig. 19.

number of attachment strain points. This distribution of strain is secured by the system of running rigging which divides the number of points on each section of rigging into systems, consisting first of 8 points taken on 4 pulleys, then the 4 pulley cords being taken on 2 of larger size, these dividing their strain on a single pulley carrying a rope transferring the whole system of 8 equally to the cable or to the car. When the balloon is hauled down, however, the division of strain into this equal distribution becomes the duty of the crew, because they have then to deal with each pair of points separately, and it is then that thoughtful care must be exercised to see that each pair of points takes its share of the holding down strain, and does not leave its duty to some adjacent pair. In high winds the safety of the balloon depends mainly on judicious management of the strain distribution.

CARE OF KITE BALLOONS.

Edited from Maj. Brabazon's Notes on Practice in the Field.

Bagging down at night.—When tethering a kite balloon in the open, the roughest of weather should be anticipated. A place should be selected where shelter of trees is available from winds blowing in all directions, especially from westerly and southwesterly winds. Often a bay in a wood with the opening toward the east may be found, and an alternative wind screen should be noted for affording shelter in the event of the wind blowing from the exposed quarter.

A balloon is far safer and less likely to suffer damage when held elastically by means of sandbags than when tethered rigidly to pickets. It is most important to remember when dealing with a balloon that it is not a rigid structure capable of taking a large strain at any one point. Anchoring means should therefore be distributed

as evenly as possible all round the balloon, and the rigging band, which is designed to take the strains of suspension when in the air, is also most fitted to take all the tethering strains when riding out a gale on the ground, providing those strains are equally distributed. It is therefore necessary to arrange each point of attachment in such a way that it can only pull with a strain not exceeding, say, 50 pounds, and when that maximum strain has been taken up the point of attachment should be capable of yielding sufficiently to bring adjacent anchoring attachments into action, and thus distribute the strain equally between the various attachments.

No means has yet been found which fulfills these requirements better than sandbags. They are portable, supple, and can only pull to the limit of their own weight. Consequently, when subject to an excess of that pull, instead of resisting rigidly and exerting a local strain on the balloon greater than should be taken at that ponit, they give way while still maintaining their maximum effort.

Almost every balloon which has broken away has done so because of the method of anchoring employed. There is no objection to steadying a balloon with guy ropes provided the balloon is evenly bagged down, each mesh of the rigging holding a similar strain. To hold a balloon down by a few ropes attached to pickets is to invite trouble when a high wind springs up. If a kite balloon has been properly bagged down and a good situation has been chosen, preferably small scattered woods, then it can safely ride out the strongest gale.

Quite apart from the danger of losing the balloon, local strains carried to the top by means of storm guys stretch the fabric and cause innumerable leaks which it is impossible to repair. The storm guy should never be used rigidly; and if used for steadying a balloon in a high wind, a weight such as a couple of sandbags attached to

each guy rope so as to rise and fall as the strain changes will save the balloon from a large portion of the strain which it would otherwise receive if rigidly attached.

The large size of rope used as the guys is for convenience in handling and is no indication that a large strain can be taken at those points.

Gas.—With regard to leakage of gas, far less leakage, or rather less loss of lift, will occur if the gas inside the balloon be maintained at a slight pressure. Loss of lift is largely brought about by holding the balloon down at night by means of inextensible stays which do not take up any slack. The result is that the lower portion of the balloon becomes flabby and tends to suck air through the pores of the fabric and through the lower seams. The entrance of a little air like this every night soon lowers the quality of the gas, until it is found that the balloon becomes unserviceable until emptied and filled up with a new charge of hydrogen. The best method to preserve the quality of the gas in the balloon is to bag the balloon down to its bed tightly every night with some of the bags standing on the ground and pulling at their various meshes and other bags being in actual suspension in order to exert their pull when the gas has shrunk owing to being chilled during the night.

Inspection for leakage.—The balloon should be gone over every day to see if any leaking has taken place, the valve should be carefully examined, and the screws round the valve should be tightened up where found to be slack. If the valve be found to leak, it may generally be made gas tight by opening and closing it quickly. The articulators may be found to be stiff at their joints, and a valve after being opened may not close effectively under the influence of its springs. The valve should therefore be inspected for leakage every time the balloon is bagged down.

Leakage detectors need to be treated with judgment. It is possible by means of a leak detector to find small

leaks of hydrogen, while it may be impossible to detect slow diffusion over the whole fabric substance. The extensive area of the fabric compared to the local spots where leakage is expected to occur is so vast that if the fabric itself permits gas to escape or air to enter to any considerable degree, the damage is far greater than if every seam and gland showed signs of leakage when tested; but even with the best material considerable leakage can still take place at the seams, and no satisfactory seam has yet been devised either in England or in France. The reason for this leakage at the seams is because the fabric is sewn and solutioned together at the seams, but it has hitherto not been practicable to vulcanize the fabric together at the seams. The gas can therefore find its way through the stitches and then sideways through the solution, especially when seams are made between fabric and rubber and not between two rubber-faced fabrics.

Rip cord and valve cord.—It is of the utmost importance that the rip cord and the valve cord should be slack inside of the balloon and at the same time be clear to run through their glands when pulled from the car. The breaking stops which temporarily hold the rip cord near the walls of the balloon should therefore be inspected each time the balloon is deflated, and also observed by way of the inspection windows when the balloon is inflated for the purpose of seeing whether the cord has become twisted in the event of one or more of the stops being accidently broken when the balloon is in use. If the rip cord or the valve cord become twisted inside the balloon, they may form knots beyond the glands, and thus resist passing through the glands when pulled from the car for the purpose of ripping or deflating the balloon. It is best to construct both the rip cord and the valve cord of platted cord or "log line," which is known not to twist readily. If the rip cord and valve cord are made of laid cord, they should be carefully stretched and

untwisted before being placed in position in the balloon. Both the rip cord and the valve cord should be examined at least once a week to ascertain whether they show signs of rotting at or near the glands, because it is known from experience with the French balloons that the action of small leakage round the cords at the glands sets up chemical action between the hydrogen and the oxygen of the atmosphere which is calculated to injure the cords.

Rigging.—Soft lay rigging has been adopted purposely on the rigging of kite balloons, in order to cause the least possible wear at the thimbles and also to obtain the greatest strength for the weight of cord and to facilitate replacements, the cord being easy to splice when repairs are required to be done in the field. The disadvantage of soft cord rests in its readiness to soak up moisture, and if left wet in a confined space it rots very quickly. Signs of mildew on the balloon indicate a condition in which the rigging will rot very soon.

When the small cords, Nos. 1 and 2, begin to break, owing to the weight of the sand bags and to the extra pull given by the men, it is well to suspect the larger ropes, viz, the A and B and the 4 and 5 ropes.

Drawings.—Every section should obtain a blue print of the balloon and its rigging, and when it is necessary to replace broken rigging this should be done to the measurements of the balloon when new and not be substituting new portions for old to the length of the old, because with wear the rigging stretches and consequently the new portions after they had stretched would soon throw the rigging out of shape. It may be well for the section while the balloon is still new to fill in spare time in making duplicate replacements of rigging on one side of the balloon and thus not be obliged to rely on the drawing entirely when the time arrives for mending a worn portion of the rigging.

O

THE RIGHT MAN IN THE RIGHT PLACE IN THE ARMY

THE ADJUTANT GENERAL'S DEPARTMENT
Committee on Classification of Personnel in the Army
WASHINGTON, D. C.

YOU ARE INVITED TO INSPECT AN

EXHIBIT OF ARMY PERSONNEL WORK

SHOWING

HOW THE ARMY FINDS OUT WHAT MEN CAN DO BEST AND HOW IT USES THAT ABILITY;

TRADE TESTS, DEMONSTRATED AND ILLUSTRATED BY PHOTOGRAPHS AND MODELS;

HOW ARMY UNITS ARE "BALANCED;"

HOW OFFICERS' RATINGS ARE SUMMARIZED AND USED;

THE RESULTS OF ARMY PERSONNEL WORK IN THE PRESENT WAR.

ROOM 530
STATE, WAR AND NAVY BUILDING
WASHINGTON, D. C

JANUARY 13TH TO 31ST
INCLUSIVE

This invitation was recently issued to army officers and others interested in Army Personnel Work. Through distance or because of previous engagements, many were prevented from attending. The purpose of this pamphlet is to bring the mountain to Mahomet.

Raw Material

In turning these pages you will see the charts and demonstrations in sequence as if you had personally attended the Exhibit.

As you "enter the Exhibit Hall," your attention is first directed to Plate 1, which tells the story in eighty-three words.


THIS EXHIBIT
DESCRIBES THE METHODS EMPLOYED IN FINDING THE RIGHT MAN FOR EACH JOB IN THE ARMY.
THE ARMY NEEDED SKILLED MEN FOR THE LINE AND FOR THE STAFF CORPS.
SKILLED MEN WERE FLOWING FROM INDUSTRY INTO THE ARMY.
THE PERSONNEL ORGANIZATION BROUGHT THE MAN AND THE JOB TOGETHER.
THE RIGHT MAN IN THE RIGHT PLACE
35901.

Plate 1

The Infantry Divisions, as well as the technical corps, need their quota of specialists.


IN EVERY 100,000 MEN
Requested By The Staff Corps
82,000
Are Occupational Specialists
IN EVERY 100,000 MEN
Needed By Infantry Divisions
40,000
Must Be Occupational Specialists
The Personnel System
Locates and Trade Tests
These Specialists

Plate 2

This Plate shows the scarcity of certain tradesmen and tells why the Army must analyze each man carefully and use him where he is most valuable.

There are not enough skilled men to fill the Army's needs.

SKILLED TRADESMEN ARE RARE

The Personnel System Conserves Them

IN EACH 10,000 MEN
Received in The Draft
There Are But:-

Accountant	68	Locomotive Fireman	140
Auto Repairer	106	Machinist	378
Blacksmith	91	Miner	317
Carpenter	261	Railroad Construction Man	3
Chemical Industrial Worker	9	Railroad Operating Man	185
Clerical Worker	578	Telegrapher	52
Electrician	155	Welder	7
Gas Engine Repairman	127	Wireless Operator	11
Instrument Repairer	2	Other Occupations (83)	3718

Total in Classified Occupations 6208

Journeymen	17 %
Apprentices	45 %
Unclassified	38 %

36342

Plate 3

Another case of insufficient supply.

HELP WANTED CHEMISTS

But 181 Chemists and Chemical Workers Occur per 100,000 drafted men/

2916 Chemists have been classified and reported by name to the Chemical Warfare Service Since May 1918

Each man's record was investigated and if found satisfactory assignments were made to Experimental Stations, Gas Shell Plants, Ordnance Work, Gas Mask Factories, Etc.

55 Varieties of Chemists are included in the Classification of "Chemists and Chemical Workers"

Plate 4

Just Arrived in Camp

This is a diagram of the building at camp where recruits are received.

Here each man is interviewed and classified, examined physically, discharged if unfit, equipped if fit, provided with insurance, turned over for training, and sent into camp IN KHAKI.

Trace the men as they pass through. See Plate 5.

Three Hours Later

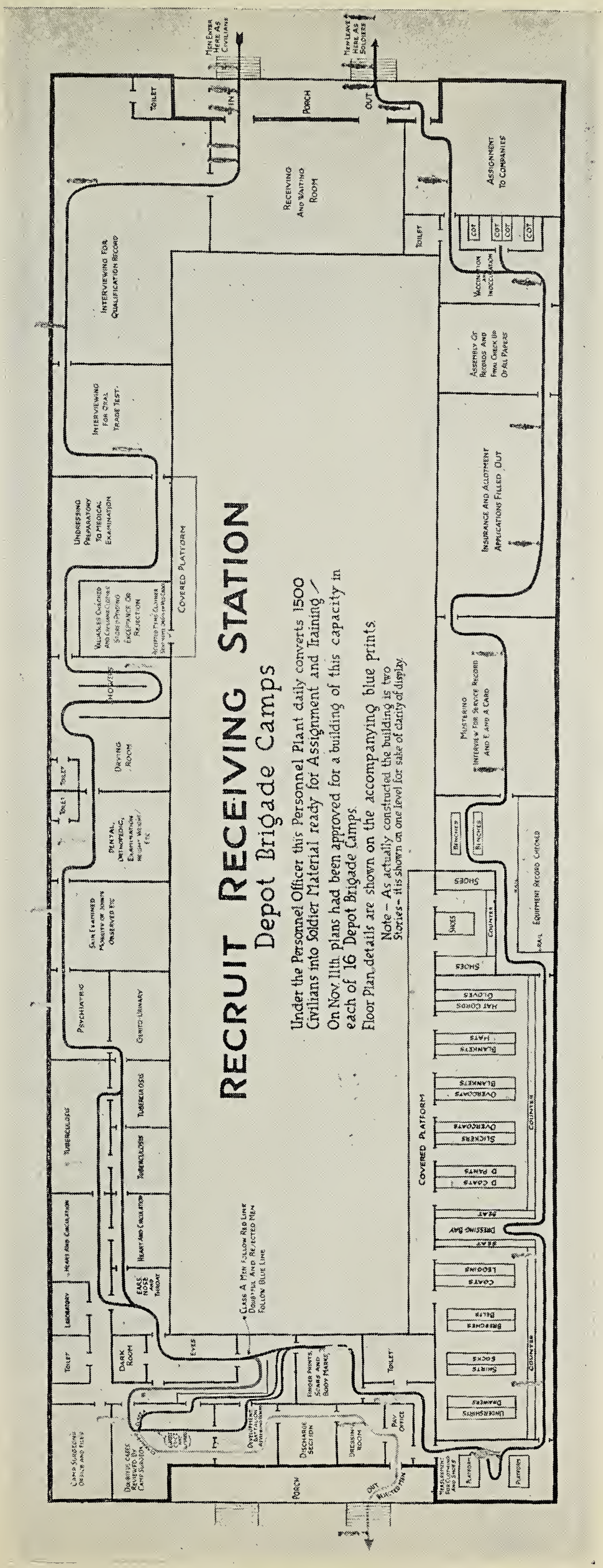

RECRUIT RECEIVING STATION
Depot Brigade Camps
Under the Personnel Officer this Personnel Plant daily converts 1500 Civilians into Soldier Material ready for Assignment and Training —
On Nov. 11th plans had been approved for a building of this capacity in each of 16 Depot Brigade Camps.
Floor Plan details are shown on the accompanying blue prints.
Note — As actually constructed the building is two stories — it is shown on one level for sake of clarity of display.
Covered Platform
Receiving and Waiting Room
Porch
Assignment to Companies
Insurance and Allotment Applications Filled Out

Plate 5

This Chart explains itself.

Details of the card are shown on page 17.

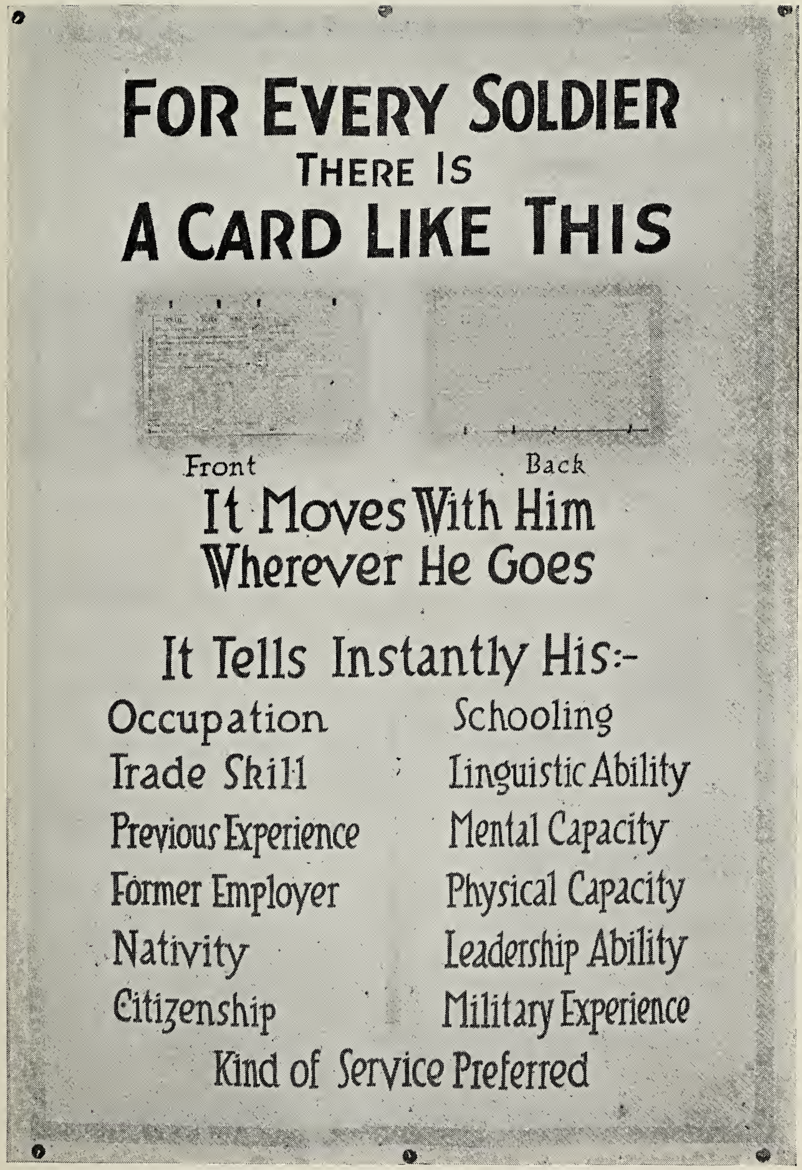
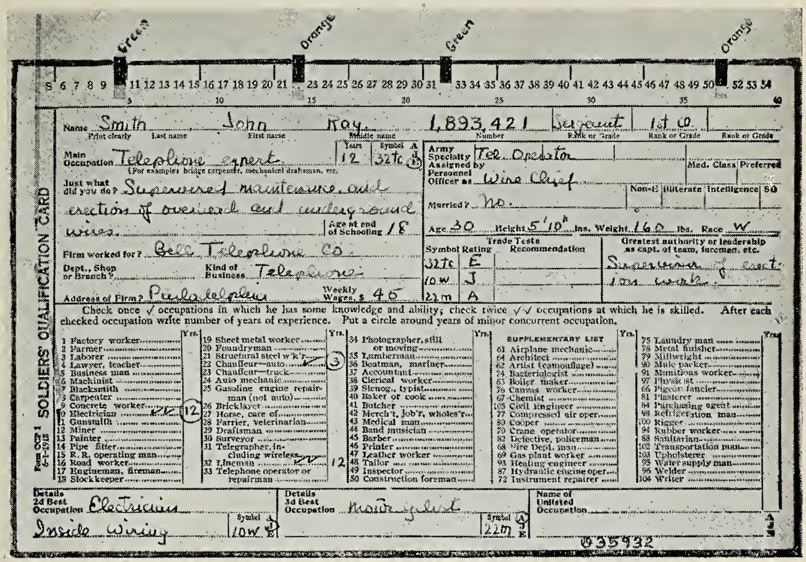

FOR EVERY SOLDIER
THERE IS
A CARD LIKE THIS
Front
Back
It Moves With Him
Wherever He Goes
It Tells Instantly His:-
Occupation
Schooling
Trade Skill
Linguistic Ability
Previous Experience
Mental Capacity
Former Employer
Physical Capacity
Nativity
Leadership Ability
Citizenship
Military Experience
Kind of Service Preferred

Plate 6

Here are the details of the Soldiers' Qualification Card.

The tabs on the top of the card indicate the man's special qualifications and make it possible to select his card from a file instantly when a man of his qualifications is wanted.

For instance, the green tab on 32 indicates "skilled lineman." The orange tab on 22 indicates "semi-skilled chauffeur." The green tab on 10 means that this man was also a skilled electrician. On 51 the orange tab indicates that he has had a high school education. A green tab on 51 would mean a college or technical education.



Green Orange Green Orange

5 6 7 8 9 11 12 13 14 15 16 17 18 19 20 21 23 24 25 26 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 52 53 54

SOLDIERS' QUALIFICATION CARD

Form CC&F 1 6-1-1918

Name Smith, John Roy. — 1,893,421 — Sergeant — 1st Cl.
Print clearly — Last name — First name — Middle name — Number — Rank or Grade — Rank or Grade — Rank or Grade

Main Occupation Telephone expert. Years 12 Symbol 32tc A J E
(For example: bridge carpenter, mechanical draftsman, etc.)

Army Specialty Tel. Operator
Assigned by Personnel Officer as Wire Chief
Med. Class — Preferred

Just what did you do? Supervised maintenance and erection of overhead and underground wires.
Age at end of Schooling 18

Married? No.
Non-E — Illiterate — Intelligence 50

Age 30 Height 5' 10" ins. Weight 160 lbs. Race W

Firm worked for? Bell Telephone Co.
Dept., Shop or Branch? Kind of Business Telephone
Address of Firm? Philadelphia Weekly Wages, $ 45

Trade Tests Symbol	Rating	Recommendation
32tc	E	
10w	J	
22m	A	

Greatest authority or leadership as capt. of team, foreman, etc. Supervision of erection work.

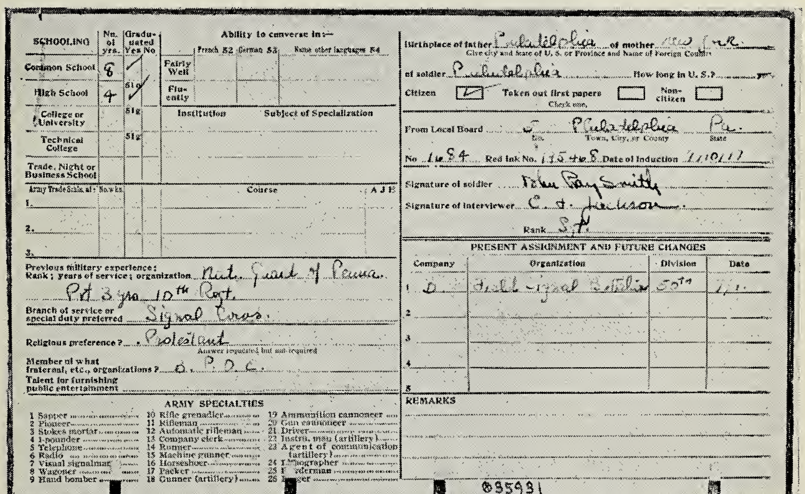
Check once √ occupations in which he has some knowledge and ability; check twice √√ occupations at which he is skilled. After each checked occupation write number of years of experience. Put a circle around years of minor concurrent occupation.

	Yrs.		Yrs.		Yrs.	Supplementary List	Yrs.		Yrs.
1 Factory worker		19 Sheet metal worker		34 Photographer, still or moving		61 Airplane mechanic		75 Laundry man	
2 Farmer		20 Foundryman		35 Lumberman		64 Architect		78 Metal finisher	
3 Laborer		21 Structural steel w'k'r		36 Boatman, mariner		62 Artist (camouflage)		79 Millwright	
4 Lawyer, teacher		22 Chauffeur—auto √	(3)	37 Accountant		74 Bacteriologist		90 Mule packer	
5 Business man		23 Chauffeur—truck		38 Clerical worker		65 Boiler maker		91 Munitions worker	
6 Machinist		24 Auto mechanic		39 Stenog., typist		76 Canvas worker		97 Physicist	
7 Blacksmith		25 Gasoline engine repairman (not auto)		40 Baker or cook		67 Chemist		66 Pigeon fancier	
8 Carpenter		26 Bricklayer		41 Butcher		105 Civil Engineer		81 Plasterer	
9 Concrete worker		27 Horse, care of		42 Merch't, job'r, wholes'r		77 Compressed air oper.		84 Purchasing agent	
10 Electrician √√	(12)	28 Farrier, veterinarian		43 Medical man		80 Cooper		98 Refrigeration man	
11 Gunsmith		29 Draftsman		44 Band musician		70 Crane operator		100 Rigger	
12 Miner		30 Surveyor		45 Barber		82 Detective, policeman		94 Rubber worker	
13 Painter		31 Telegrapher, including wireless		46 Printer		68 Fire Dept. man		88 Sanitarian	
14 Pipe fitter		32 Lineman √√	12	47 Leather worker		69 Gas plant worker		102 Transportation man	
15 R. R. operating man		33 Telephone operator or repairman		48 Tailor		93 Heating engineer		103 Upholsterer	
16 Road worker				49 Inspector		87 Hydraulic engine oper.		95 Water supply man	
17 Engineman, fireman				50 Construction foreman		72 Instrument repairer		96 Welder	
18 Stockkeeper								104 Writer	

Details 2d Best Occupation Electrician Inside Wiring Symbol 10w A J E
Details 3d Best Occupation Motor cyclist Symbol 22m A J E
Name of Unlisted Occupation

035932

Front



SCHOOLING	No. of yrs.	Graduated Yes	No
Common School	6	√	
High School	4	51a √	
College or University		51b	
Technical College		51c	
Trade, Night or Business School			

Ability to converse in:— French 52 German 53 Name other languages 54
Fairly Well
Fluently

Institution — Subject of Specialization

Army Trade Schools at: — No. wks. — Course — A J E
1.
2.
3.

Previous military experience; Rank; years of service; organization Nat. Guard of Penna. Pvt 3 yrs 10th Regt.

Branch of service or special duty preferred Signal Corps.

Religious preference? Protestant
Answer requested but not required

Member of what fraternal, etc., organizations? O. P. O. C.

Talent for furnishing public entertainment

ARMY SPECIALTIES

1 Sapper	10 Rifle grenadier	19 Ammunition cannoneer
2 Pioneer	11 Rifleman	20 Gun cannoneer
3 Stokes mortar	12 Automatic rifleman	21 Driver
4 1-pounder	13 Company clerk	22 Instru. man (artillery)
5 Telephone	14 Runner	23 Agent of communication (artillery)
6 Radio	15 Machine gunner	24 Topographer
7 Visual signalman	16 Horseshoer	25 Fielderman
8 Wagoner	17 Packer	26 Ranger
9 Hand bomber	18 Gunner (artillery)	

Birthplace of father Philadelphia of mother New York
Give city and State of U. S. or Province and Name of Foreign Country

of soldier Philadelphia How long in U. S.? yrs.

Citizen [√] Taken out first papers [ ] Non-citizen [ ]
Check one.

From Local Board 5 Philadelphia Pa.
No. — Town, City, or County — State

No 1084 Red Ink No. 1354 Date of Induction 7/10/17

Signature of soldier John Roy Smith
Signature of interviewer C. A. Jackson
Rank Sgt.

PRESENT ASSIGNMENT AND FUTURE CHANGES

	Company	Organization	Division	Date
1	D	Field Signal Battalion	50th	7/1
2				
3				
4				
5				

REMARKS

035931

Back

Plate 7

The recruit does not fill out his own Qualification Card. It is filled out for him by an interviewer trained in drawing out the actual facts by cross-examination.

Plate 8

A file of Soldiers' Qualification Cards tabbed to indicate their special qualifications.

The cards of specialists (e. g., machinists, photographers, electricians) can be immediately withdrawn for inspection by the use of these tabs.

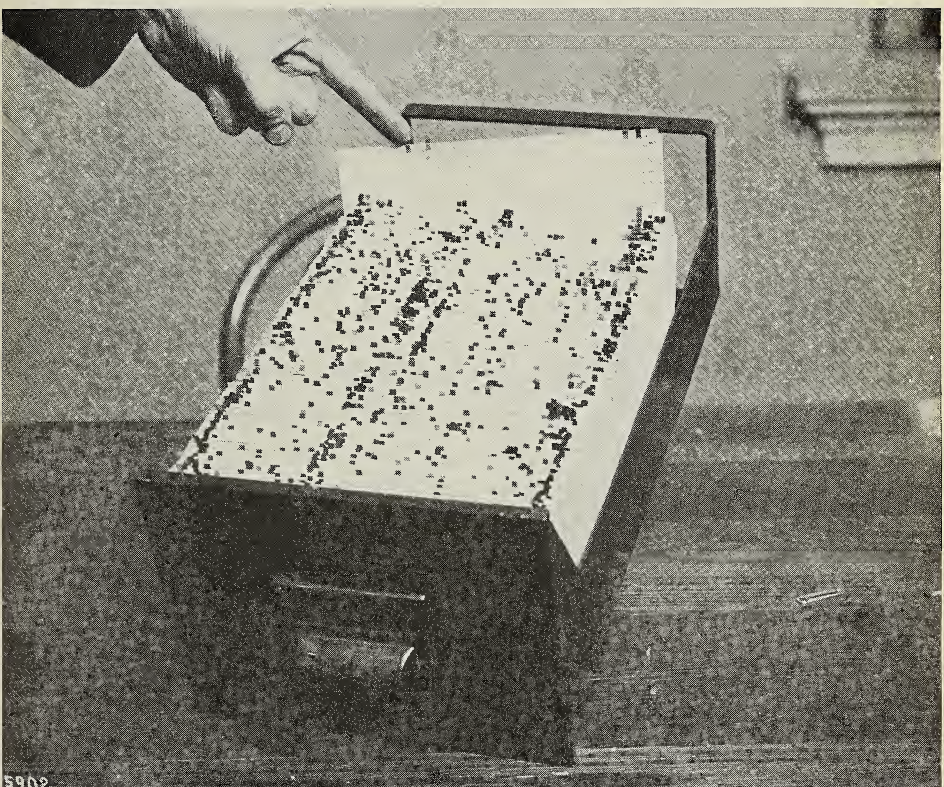


Plate 9

A page of Army Trade Specifications.

714 occupations make up the Army's classification system.

The Army Trade Specifications define each of these kinds of occupational skill and prevents misunderstanding of terms. Their use ensures that men of JUST THE RIGHT KIND are sent to fill needs.

B

FAMEK 7-fm FORGING MACHINE OPERATOR

DUTIES

1. Operation of standard types and various kinds and sizes of forging machines, such as bulldozes and hydraulic presses on general work.

QUALIFICATIONS

2. Should have thorough knowledge of rivet and bolt forging machines, screw, toggle and hydraulic presses for heading staybolts, forms, and all classes of press forgings of various materials. 55

Should have a practical knowledge of coal, gas, and oil types of forge furnace, and the proper heating of various material for forgings.

Must be able to set and adjust dies and maintain same and be able to turn out uniformly dimensioned product.

SUBSTITUTE OCCUPATIONS

3. Drop forge operator, press operator, heavy forge blacksmith, blacksmith.

HADGA 7-he HEAT TREATER

DUTIES

1. Heat treatment in general of steel forgings, finished parts and castings.

QUALIFICATIONS

2. Must be thoroughly experienced in the heating and oil treatment of various grades of steel for annealing or toughening for any kind of work. Must be capable of annealing, quenching and drawing of all kinds of steel forgings and castings, either rough or after being machined. Must be capable of judging temperature by the eye, and familiar with the use of pyrometers.

Must thoroughly understand the construction and operation of standard types of coke, oil, gas or electric furnace equipment, and quenching tanks, and have a working knowledge of the metallurgy of steel, at least sufficient to know how it should be heated, treated and cooled, under instruction or by test. 56

Should have had similar experience in forge shop of any industrial plant.

SUBSTITUTE OCCUPATIONS

3. Annealer, heater, forge heater.

HAEWS 7-h HORSESHOER

DUTIES

1. Shoeing horses and mules.

QUALIFICATIONS

2. Must be a practical horseshoer, capable of forging, shaping and punching horse or mule shoes from standard stock or bar material. Capable of removing shoes, paring and dressing hoofs, welding caulks, shaping shoes for correction of diseased or malformed feet.

Should have some veterinary knowledge, enabling him to care for and correct hoof troubles. 57

Must be able to handle and shoe unbroken horses under rough field conditions, and handle heavy horses and mules.

Should have some knowledge of blacksmithing and be able to make welds and do light blacksmith work.

Experienced as commercial horseshoer or as horseshoer in construction camp, or employee of company having considerable stock.

SUBSTITUTE OCCUPATIONS

3. Farrier, country blacksmith, blacksmith.

Plate 10

For all Army units, specifications are prepared showing just what each man must be able to do. These tables are used when selecting the right men for special organizations, units in line or staff corps.

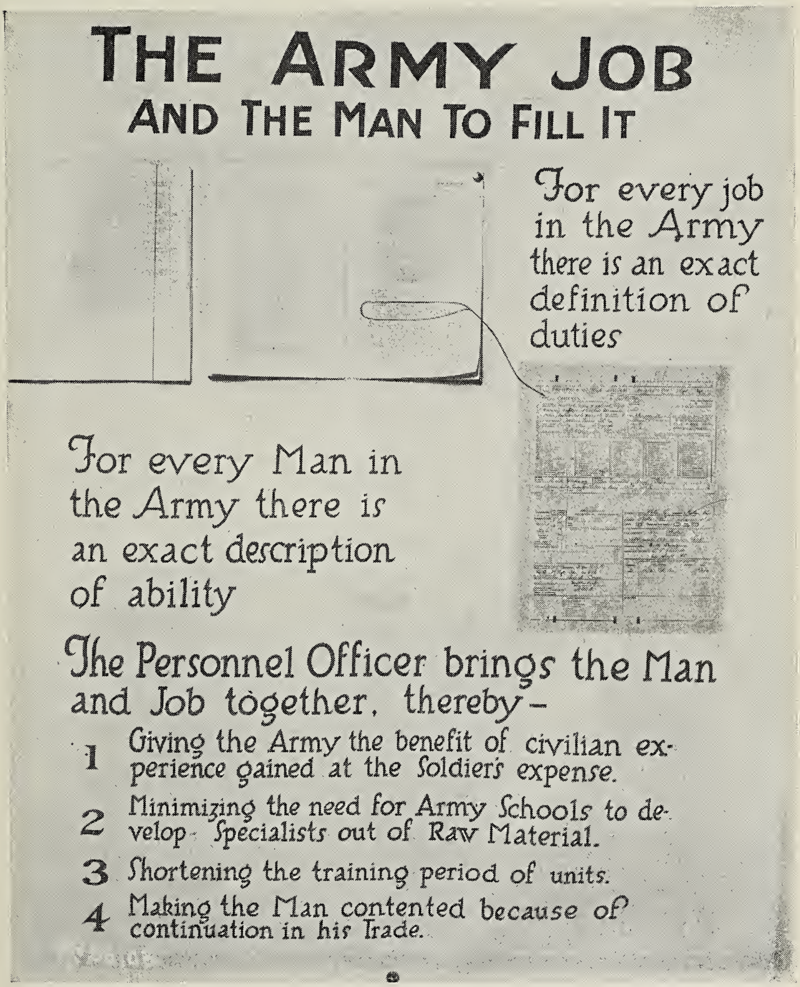

THE ARMY JOB
AND THE MAN TO FILL IT
For every job in the Army there is an exact definition of duties
For every Man in the Army there is an exact description of ability
The Personnel Officer brings the Man and Job together, thereby–
1 Giving the Army the benefit of civilian experience gained at the Soldier's expense.
2 Minimizing the need for Army Schools to develop Specialists out of Raw Material.
3 Shortening the training period of units.
4 Making the Man contented because of continuation in his Trade.

Plate 11

A "close-up" of a page of The Personnel Specifications for a unit in the Air Service.

FOUNDRY AND SUNDRIES COMPANY
(Sixth Company)

MOTOR MECHANICS REGIMENT

(TABLES OF ORGANIZATION No. 307)

Army title set in bold face type followed on the same line by the corresponding civilian occupation, the number of men, the degree of skill and the occupational symbol.
On the next line appears the suggested substitute occupation.
Then follows the description of army duties.

---

2 Master Signal Electricians:

1 Machinist.................Mechanic, general — 1 Jour. 6g

Substitute: Machinist, heavy lathe operator; milling machine operator.

Chief of section, finishing specially made parts for airplane repairs and automobiles and trucks not supplied in the "unit of spares." Frequently small fittings, such as rocker arms, rigging fittings, odd-sized brackets, etc., are manufactured in this unit. Ability to execute work from drawings is essential.

1 Toolmaker. . Machinist, toolmaker, gauge expert — 1 Jour. 6to

Substitute: Machinist, lathe operator; machinist, general.

Chief of section, making dies, tools and jigs to be used in machine shop in completing the finishing of manufactured repair parts.

12 Sergeants, First Class:

1 Acting First Sergeant. . Boss, foreman or superintendent; leadership material; mechanical ability. — 1 Uncl.

Agent of company commander in maintaining discipline. Manages company under direction of company commander, arranging details in execution of orders, and assigning men to various employments. Required to act on own initiative in emergencies in absence of company officers. Supervises the preparation of company reports, returns and correspondence.

3 Machinists................Mechanic, general — 3 Jour. 6g

Substitute: Machinist, milling machine operator.

Act as assistant foremen in the finishing of spare parts and the finishing of parts made in this unit. Inspect the finished work and must know the uses of various gauges, such as micrometers, calipers, snap, plug and limit gauges.

2 Toolmakers..Machinist, toolmaker, gauge expert — 2 Jour. 6to

Substitute: Master mechanic, railroad.

Assistant foremen to chief toolmaker. Act as inspectors and testers for accuracy in die and

035925

Plate 12

Washington knows how many men of occupational skill there are in each camp in the United States.

Washington also knows where these men are needed.

To fill requisitions, men are ordered by occupational qualifications from the camps where they are known to be available.

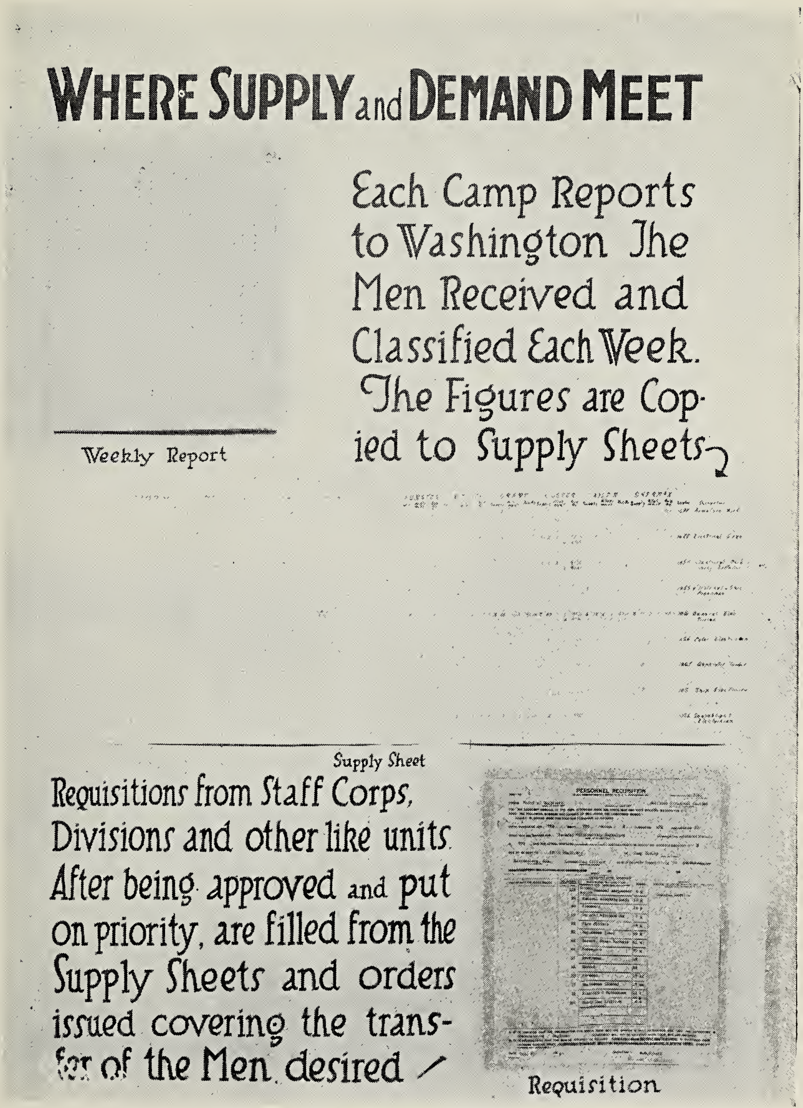

WHERE SUPPLY and DEMAND MEET
Each Camp Reports to Washington The Men Received and Classified Each Week. The Figures are Copied to Supply Sheets
Weekly Report
Supply Sheet
Requisitions from Staff Corps, Divisions and other like units After being approved and put on priority, are filled from the Supply Sheets and orders issued covering the transfer of the Men desired
PERSONNEL REQUISITION
Requisition

Plate 13

Plate 14 gives an idea of what was accomplished by the Army Personnel System.

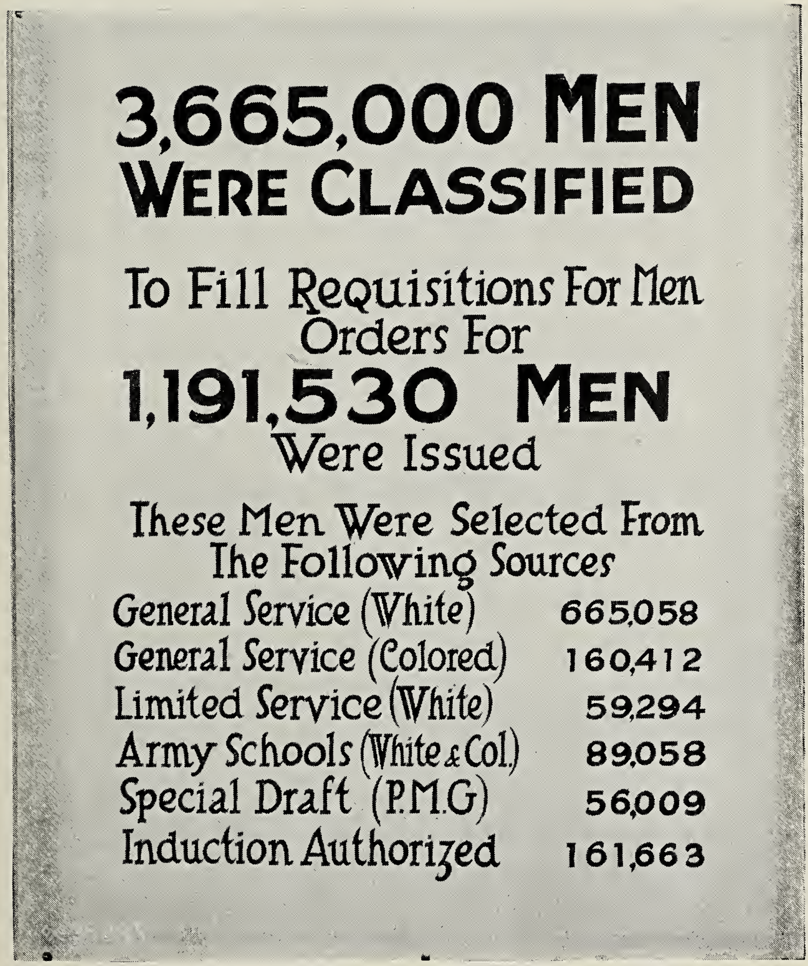

3,665,000 MEN
WERE CLASSIFIED
To Fill Requisitions For Men
Orders For
1,191,530 MEN
Were Issued
These Men Were Selected From
The Following Sources
General Service (White) 665,058
General Service (Colored) 160,412
Limited Service (White) 59,294
Army Schools (White & Col.) 89,058
Special Draft (P.M.G) 56,009
Induction Authorized 161,663

Plate 14

Plate 15 shows how far the demand from the various branches of the service for occupational specialists exceeded the supply. The clear portions of each line indicates the unfilled requisitions on November 11, 1918.

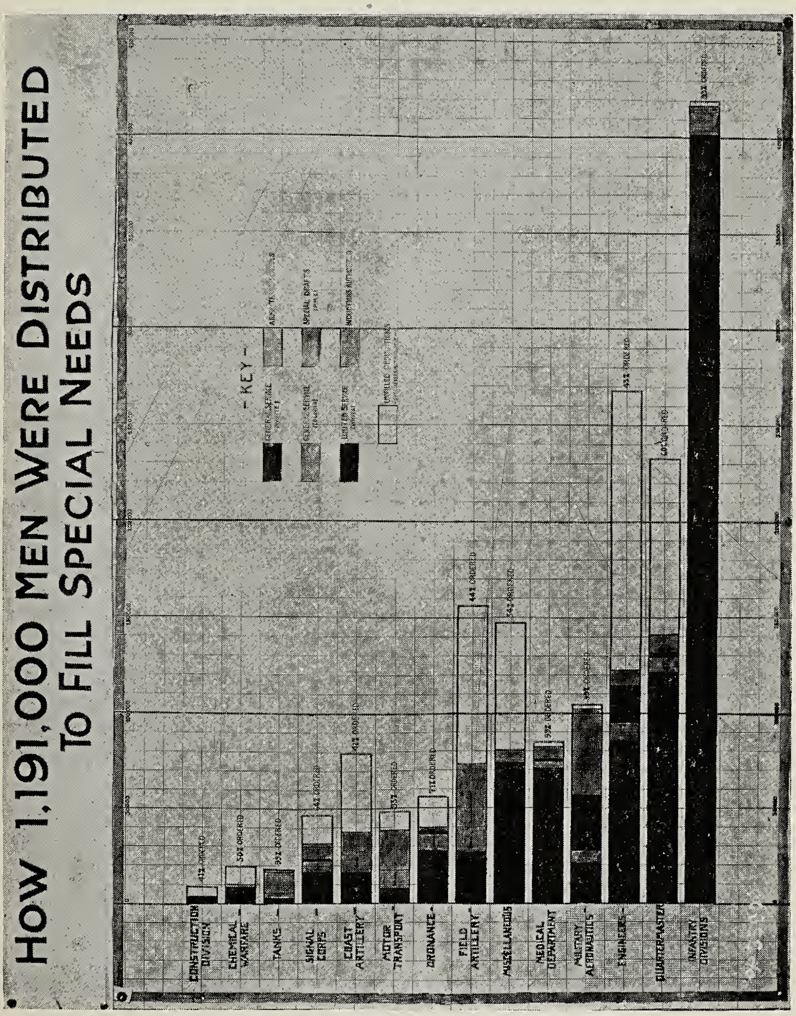

How 1,191,000 Men Were Distributed
To Fill Special Needs
- KEY -
Construction Division
Chemical Warfare
Tanks
Signal Corps
Coast Artillery
Motor Transport
Ordnance
Field Artillery
Miscellaneous
Medical Department
Military Aeronautics
Engineers
Quartermaster
Infantry Divisions

Plate 15

The Officers' Qualification Card is larger than the Soldiers' Card and is more comprehensive.

It also includes the officer's periodic RATING in certain qualities which is used as a basis for his promotion, transfer or discharge.

Details of Card are shown on page 37.

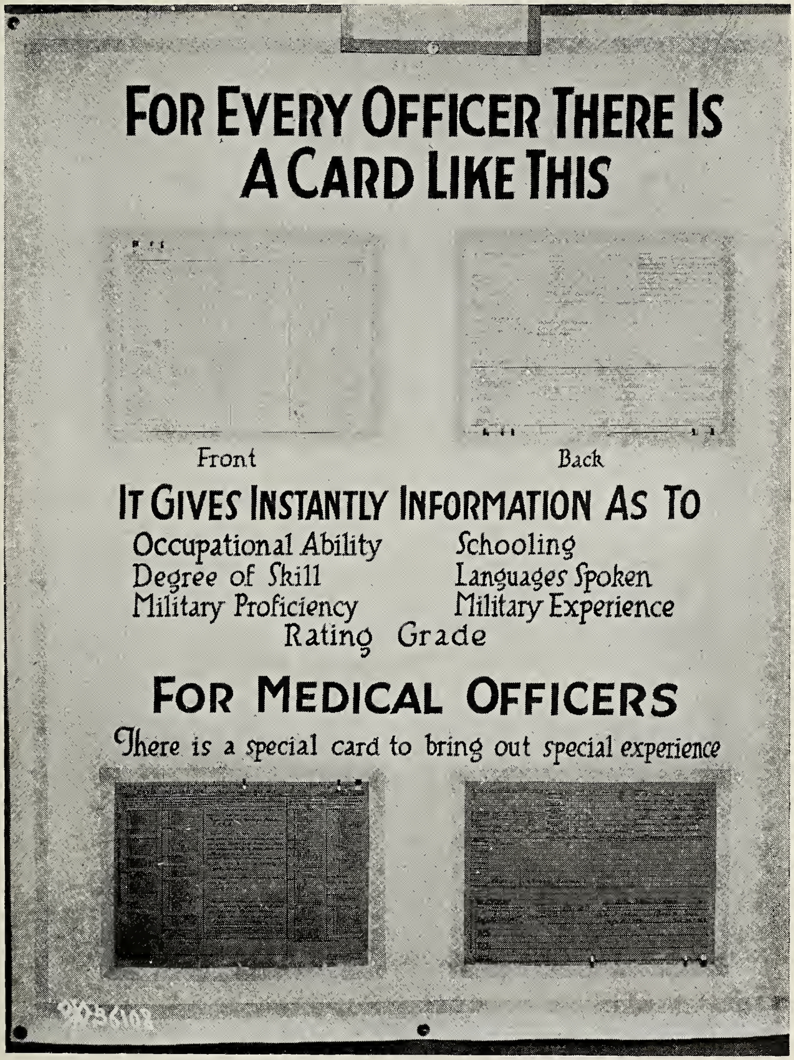
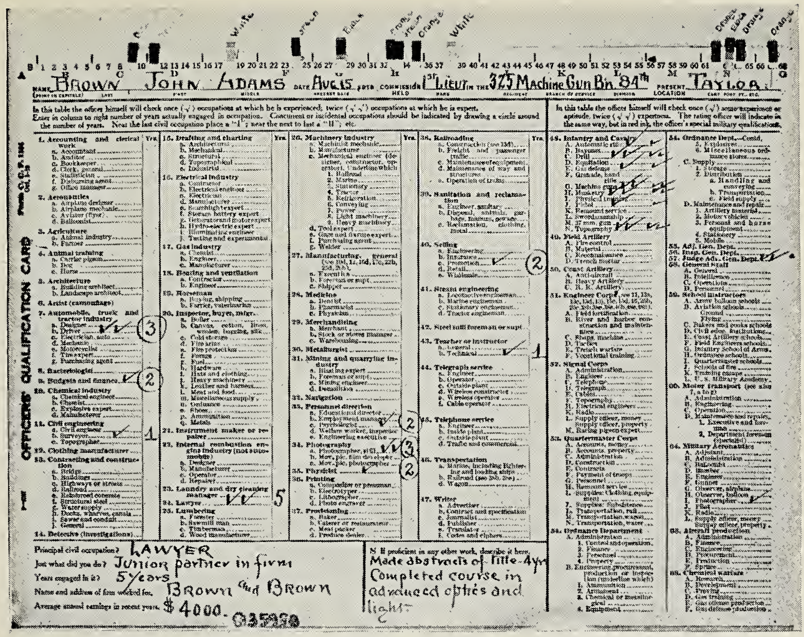

FOR EVERY OFFICER THERE IS
A CARD LIKE THIS
Front
Back
IT GIVES INSTANTLY INFORMATION AS TO
Occupational Ability
Schooling
Degree of Skill
Languages Spoken
Military Proficiency
Military Experience
Rating Grade
FOR MEDICAL OFFICERS
There is a special card to bring out special experience

Plate 16

Showing the detail of the Officers' Qualification Card.



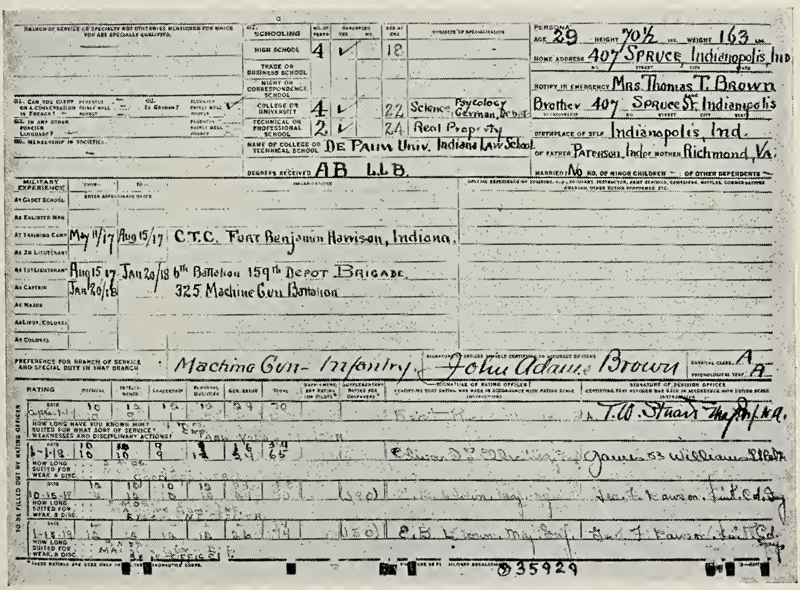
OFFICERS' QUALIFICATION CARD

Name: BROWN, JOHN ADAMS — Date: Aug 15 — Commission held: 1st Lieut in the 325 Machine Gun Bn. 84th — Present location: TAYLOR

Principal civil occupation? LAWYER
Just what did you do? Junior partner in firm
Years engaged in it? 5 years
Name and address of firm worked for. Brown and Brown
Average annual earnings in recent years. $4000. 035930

S. If proficient in any other work, describe it here. Made abstracts of title-4yrs Completed course in advanced optics and light

Front



Schooling	No. of years	Graduated	Age at end	Subjects of specialization
High school	4	✓	18	
Trade or business school				
Night or correspondence school				
College or university	4	✓	22	Science Psycology German, Debate
Technical or professional school	2	✓	24	Real Property

Name of college or technical school: De Pauw Univ. Indiana Law School
Degrees received: AB LLB.

Age 29 Height 70½ in. Weight 163 lb.
Home address 407 Spruce, Indianapolis, Ind
Notify in emergency Mrs. Thomas T. Brown, Brother 407 Spruce St. Indianapolis
Birthplace of self Indianapolis, Ind. of father Paterson, Ind. of mother Richmond, Va.
Married? No

At training camp May 11/17 Aug 15/17 C.T.C. Fort Benjamin Harrison, Indiana.
As 1st Lieutenant Aug 15 17 Jan 20/18 6th Battalion 159th Depot Brigade.
As Captain Jan 20/18 325 Machine Gun Battalion

Preference for branch of service and special duty in that branch: Machine Gun - Infantry. John Adams Brown

035929

Back

Plate 17

Plate 18 shows the system for selecting officers.

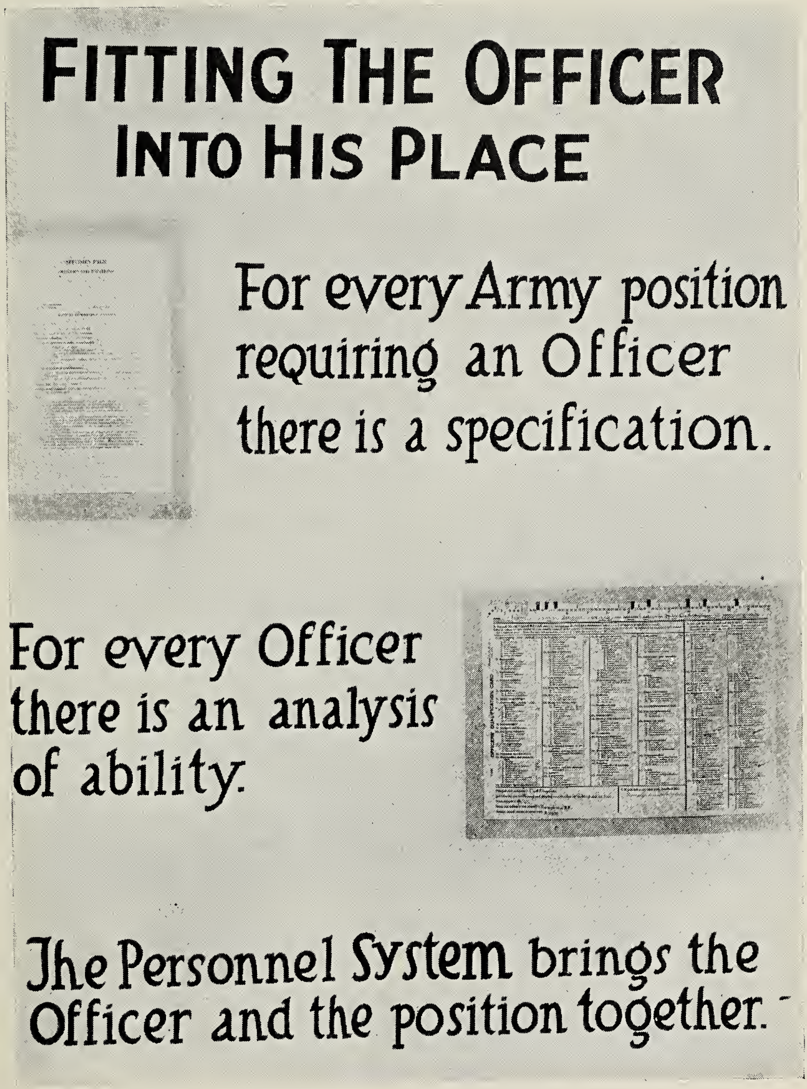

FITTING THE OFFICER
INTO HIS PLACE
For every Army position
requiring an Officer
there is a specification.
For every Officer
there is an analysis
of ability.
The Personnel System brings the
Officer and the position together.

Plate 18

Each officer's ratings of his subordinates are carefully studied at Washington. If an officer consistently rates too high or too low, his error is pointed out to him.

A sheet like this is prepared for each camp. In the left hand column are the names of the rating officers. The rating of each of their subordinates is indicated by a dot on the line of his name. The AVERAGE OF RATINGS given by each officer is indicated by the black spot opposite his name.

Comments are entered in the right hand column before the sheet is sent to camp.

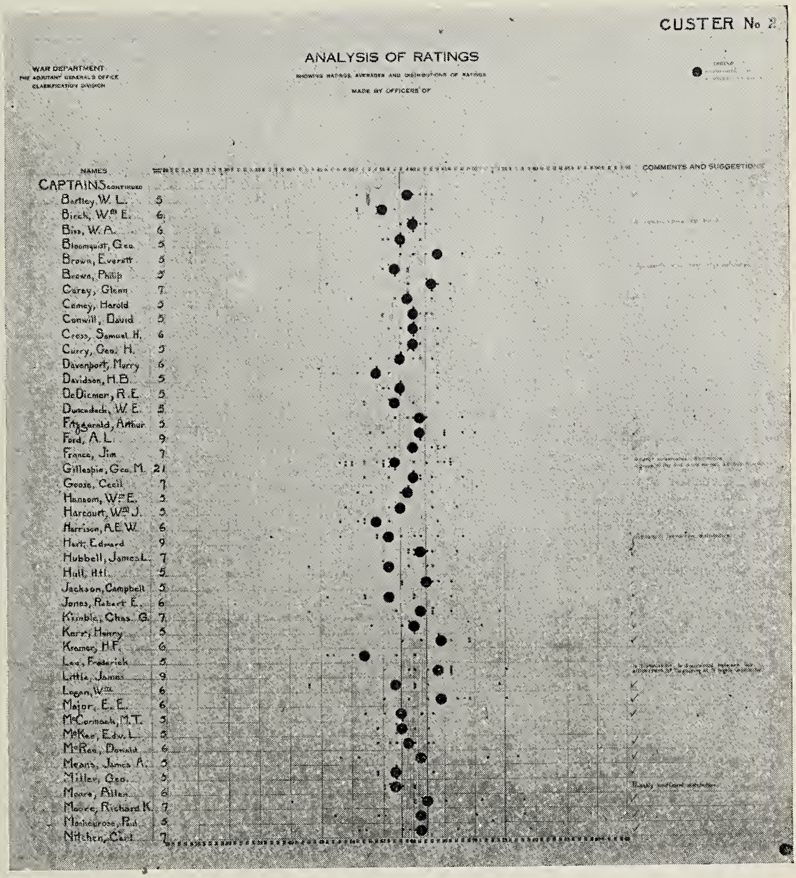

CUSTER No 2
WAR DEPARTMENT
ANALYSIS OF RATINGS
MADE BY OFFICERS OF
NAMES
COMMENTS AND SUGGESTIONS
CAPTAINS CONTINUED
Bartley, W. L. 5
Birch, Wm E. 6
Biss, W. A. 6
Bloomquist, Geo. 5
Brown, Everett 5
Brown, Philip 5
Carey, Glenn 7
Carney, Harold 5
Conwill, David 5
Cross, Samuel H. 6
Curry, Geo. H. 5
Davenport, Murry 6
Davidson, H. B. 5
DeDiemer, R. E. 5
Duncedeck, W. E. 5
Fitzgerald, Arthur 5
Ford, A. L. 9
France, Jim 7
Gillespie, Geo. M. 21
Goose, Cecil 7
Hansom, Wm E. 5
Harcourt, Wm J. 5
Harrison, A. E. W. 6
Hart, Edward 9
Hubbell, James L. 7
Hull, H. H. 5
Jackson, Campbell 5
Jones, Robert E. 6
Kimble, Chas. G. 7
Kerr, Henry 5
Kramer, H. F. 6
Lee, Frederick 5
Little, James 9
Logan, Wm 6
Major, E. E. 6
McCormack, M. T. 5
McKee, Edw. L. 5
McRae, Donald 6
Means, James A. 5
Miller, Geo. 5
Moore, Allen 6
Moore, Richard K. 7
Monkeyrose, Paul 5
Nitchen, Carl 7

Plate 19

Psychological Tests are given officers and men to determine intelligence and mental alertness.

"A" men are those of superior intelligence. "C" men are average men. "D" men are slow and of inferior intelligence.

Notice the high proportion of low-grade men among the disciplinary cases, the high proportion of superior men among those selected for promotion.

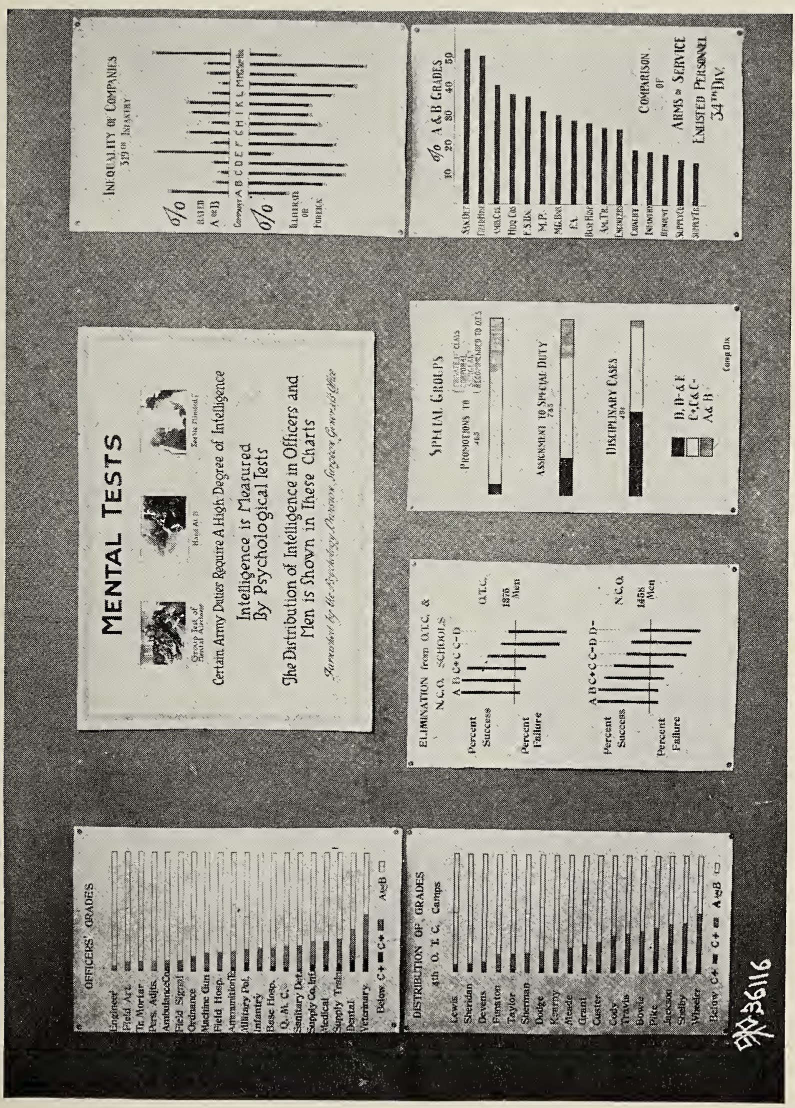

MENTAL TESTS
Certain Army Duties Require A High Degree of Intelligence
Intelligence is Measured By Psychological Tests
The Distribution of Intelligence in Officers and Men is Shown in These Charts
OFFICERS' GRADES
DISTRIBUTION OF GRADES 4th O. T. C. Camps
ELIMINATION from O.T.C. & N.C.O. SCHOOLS
Percent Success
Percent Failure
SPECIAL GROUPS
ASSIGNMENT TO SPECIAL DUTY
DISCIPLINARY CASES
INEQUALITY OF COMPANIES
% A & B GRADES
COMPARISON OF ARMS & SERVICE ENLISTED PERSONNEL 34TH DIV.

Plate 20

Men who claim skill in trades essential to the Army are tested to determine just how skilled they are.

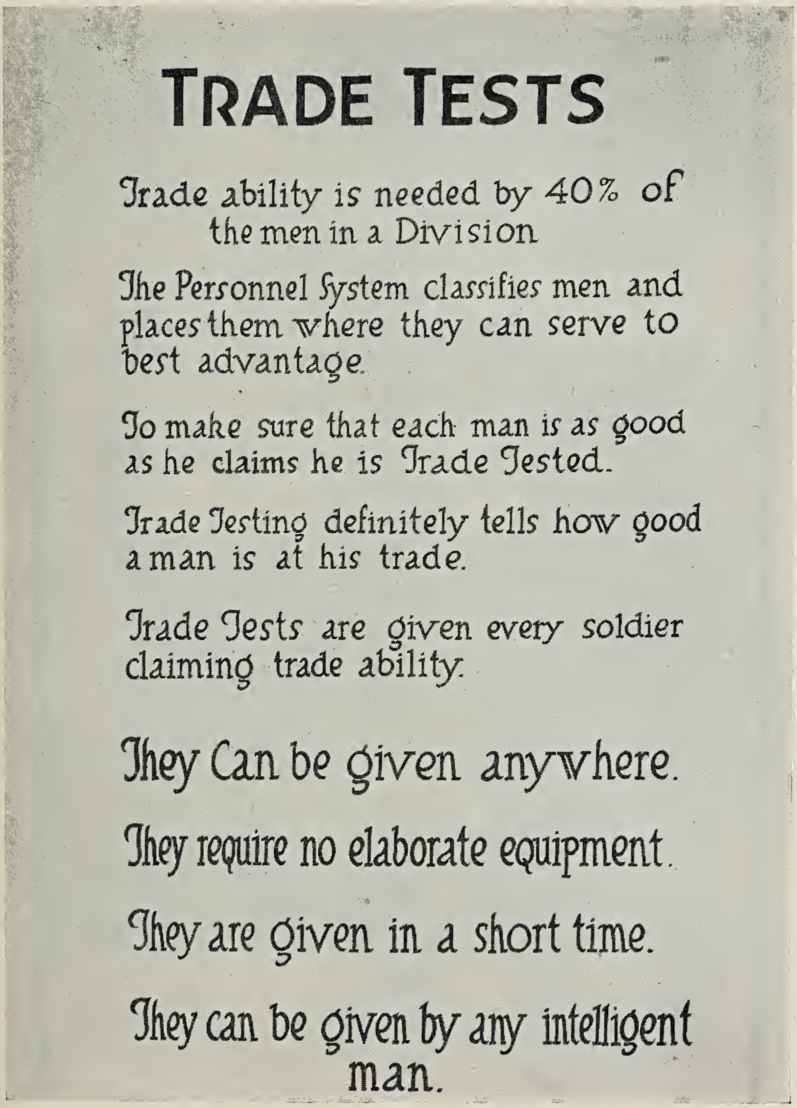

TRADE TESTS
Trade ability is needed by 40% of the men in a Division
The Personnel System classifies men and places them where they can serve to best advantage.
To make sure that each man is as good as he claims he is Trade Tested.
Trade Testing definitely tells how good a man is at his trade.
Trade Tests are given every soldier claiming trade ability.
They Can be given anywhere.
They require no elaborate equipment.
They are given in a short time.
They can be given by any intelligent man.

Plate 21

Over 100 Trade Tests had been developed and additional tests were being produced.

There are three kinds of trade tests: oral, picture and performance.

These tests, in a few minutes, classify men into four grades of skill: novice, apprentice, journeyman, expert.

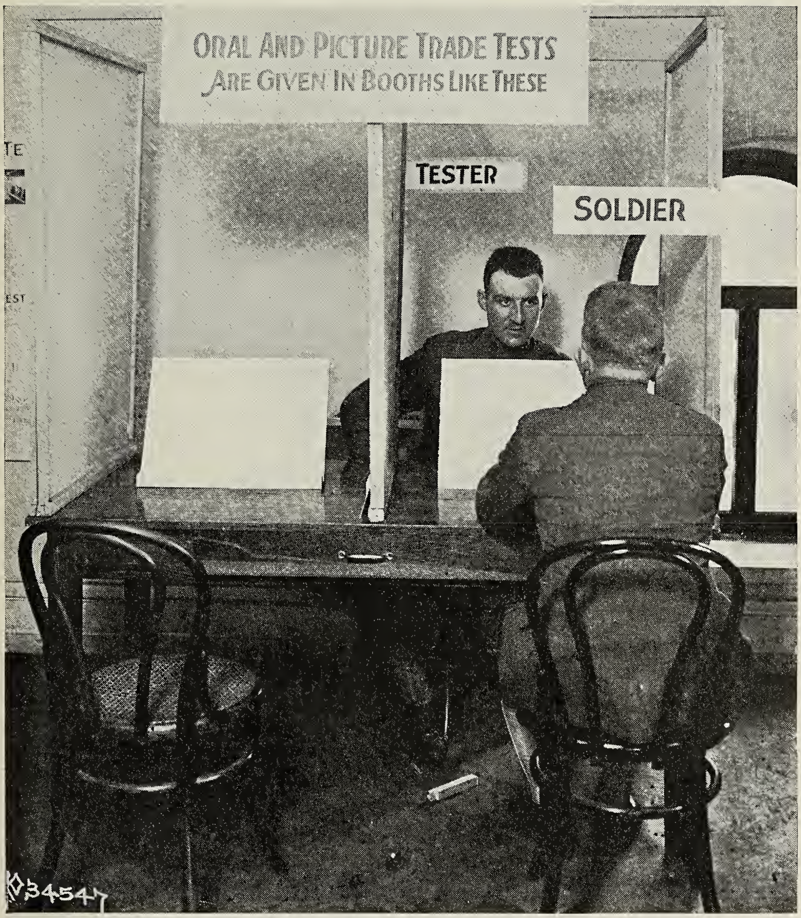

ORAL AND PICTURE TRADE TESTS
ARE GIVEN IN BOOTHS LIKE THESE
TESTER
SOLDIER

Plate 22

The Army trade tests are so constructed that they can be given by any intelligent man regardless of his trade skill. You may not be an expert lithographic pressman but you can test men who claim they are expert—and classify them properly.

That is, you can do so after they have been trained how to do it.

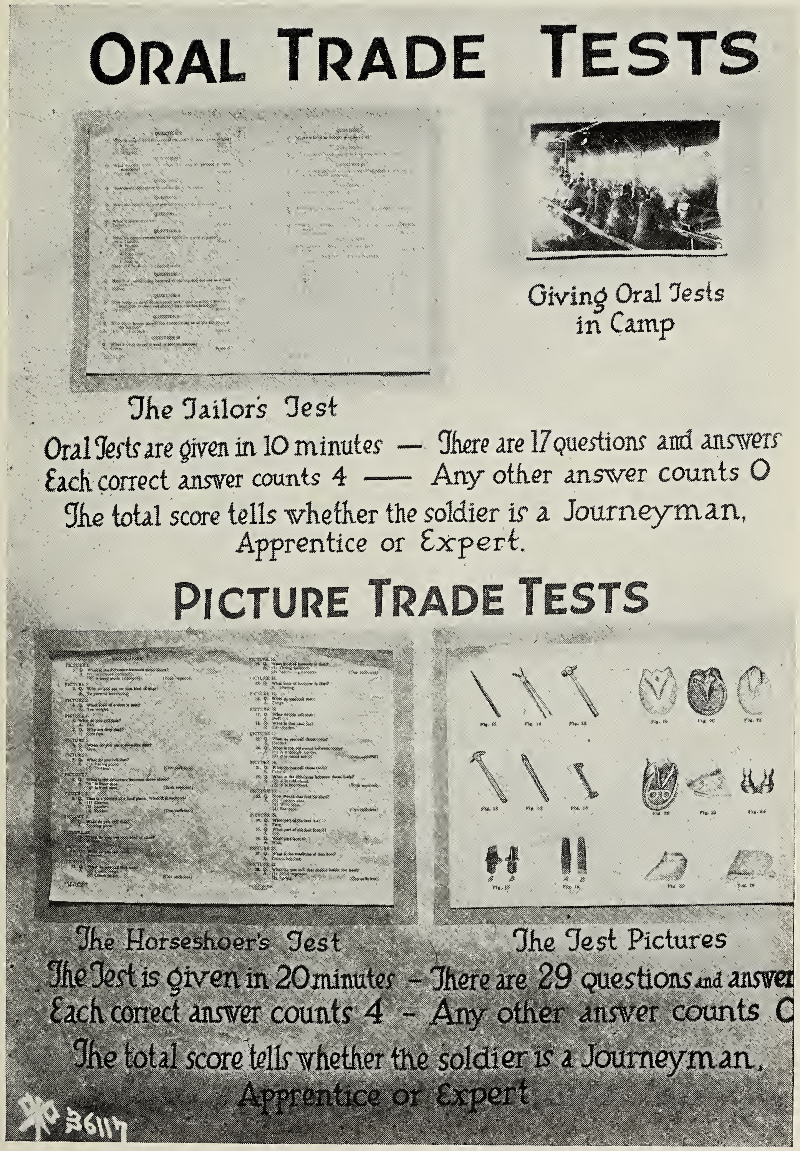

ORAL TRADE TESTS
Giving Oral Tests in Camp
The Tailor's Test
Oral Tests are given in 10 minutes — There are 17 questions and answers
Each correct answer counts 4 — Any other answer counts 0
The total score tells whether the soldier is a Journeyman, Apprentice or Expert.
PICTURE TRADE TESTS
The Horseshoer's Test
The Test Pictures
The Test is given in 20 minutes — There are 29 questions and answer
Each correct answer counts 4 — Any other answer counts
The total score tells whether the soldier is a Journeyman, Apprentice or Expert
36117

Plate 23

A Chart of the Blacksmiths' Performance Test.

In order to weld the two pieces of iron and make this hook the recruit must know the essential operations of the trade.

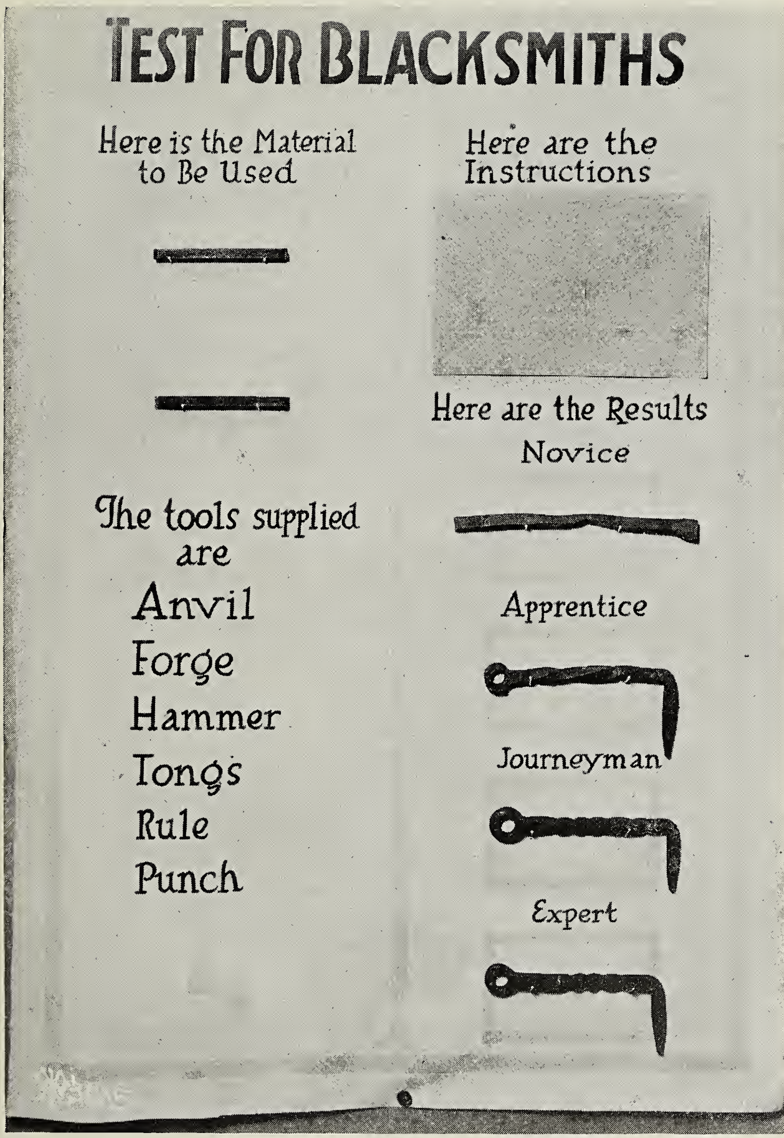

TEST FOR BLACKSMITHS
Here is the Material to Be Used
Here are the Instructions
Here are the Results
Novice
The tools supplied are
Anvil
Forge
Hammer
Tongs
Rule
Punch
Apprentice
Journeyman
Expert

Plate 24

Here is an aeroplane view of a model of the course used in testing Truck Drivers.

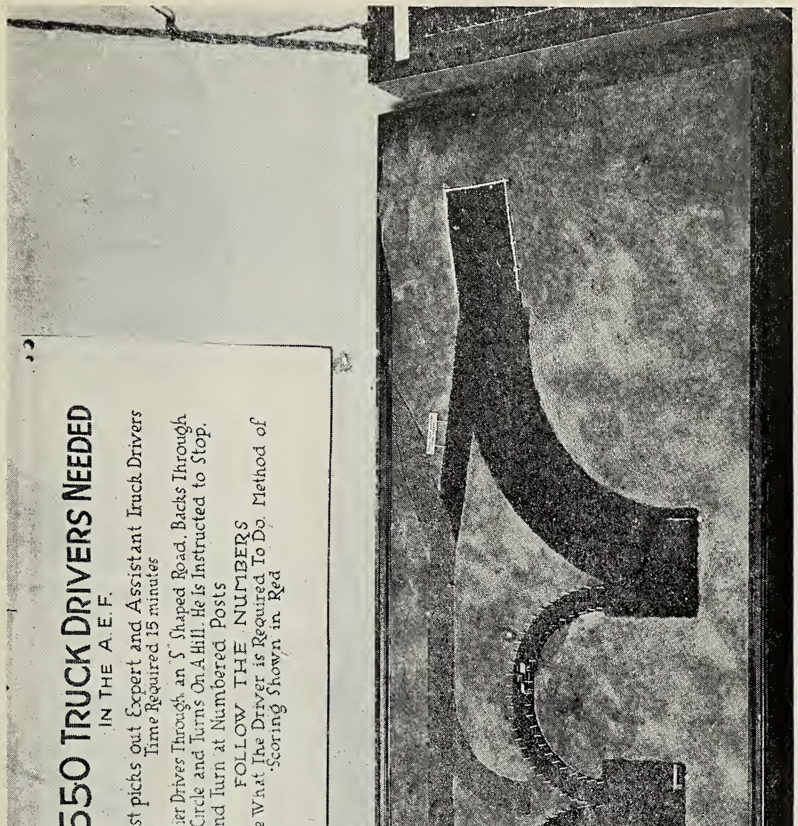

92,550 TRUCK DRIVERS NEEDED
IN THE A.E.F.
This Test picks out Expert and Assistant Truck Drivers
Time Required 15 minutes
The Soldier Drives Through an "S" Shaped Road, Backs Through A Half Circle and Turns On A Hill. He Is Instructed to Stop, Start and Turn at Numbered Posts
FOLLOW THE NUMBERS
And See What The Driver is Required To Do. Method of Scoring Shown in Red

Plate 25

And here is the model of the course for testing Auto Drivers.

The hazards are numerous and the penalties are severe, but a skilled driver will experience no difficulty in qualifying.

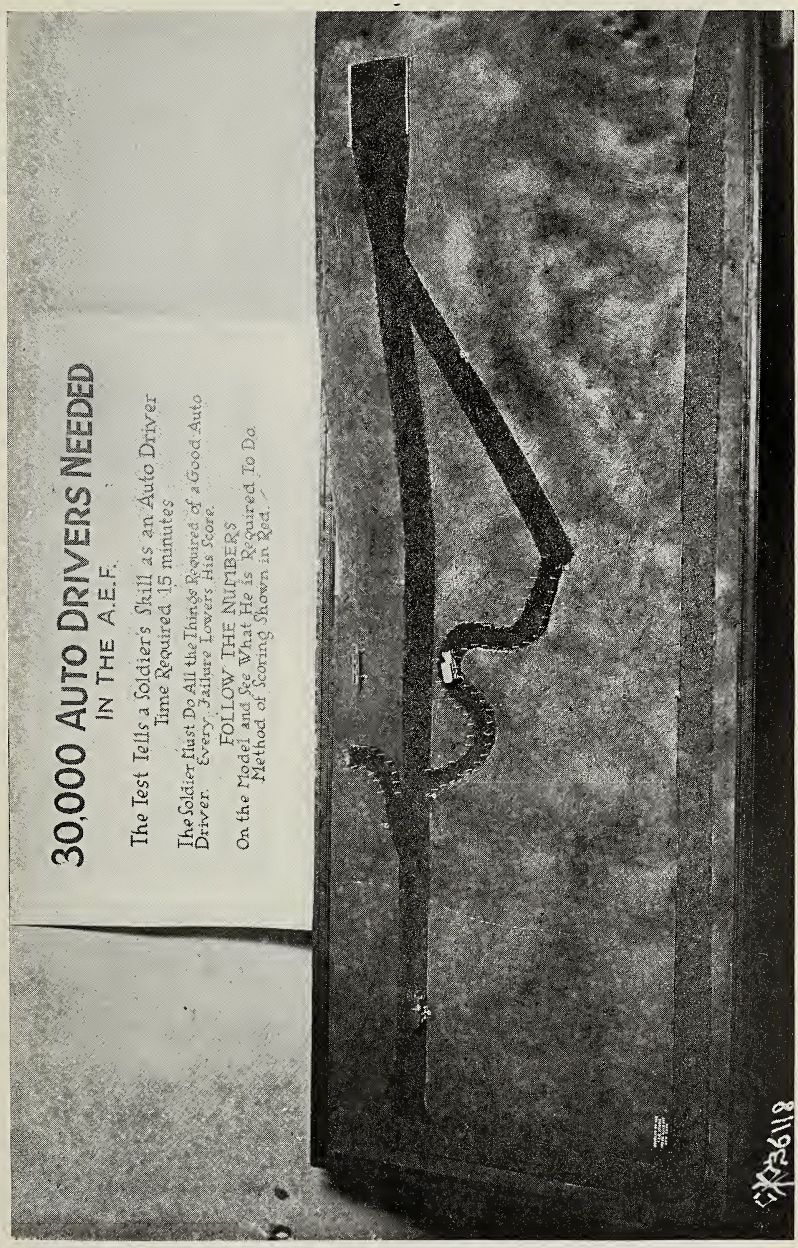

30,000 AUTO DRIVERS NEEDED
IN THE A.E.F.
The Test Tells a Soldier's Skill as an Auto Driver
Time Required 15 minutes
The Soldier Must Do All the Things Required of a Good Auto Driver. Every Failure Lowers His Score.
FOLLOW THE NUMBERS
On the Model and See What He is Required To Do.
Method of Scoring Shown in Red.

Plate 26

Here is a recruit taking the performance test for a Lineman.


LINEMAN
SCORING
Each part of the
separately.
If No. 12 Copper Wire
to make the tie Score 4
Any other kind of Wire
Score 0
The separate scores are added
together to give the final score
which tells the Degree of Skill
If a Soldier Scores
0 to 14 points
14 to 30
31 to 40
41 to 48
He is called
Novice
Apprentice
Journeyman
Expert
ED JOB

Plate 27

The performance test for a Pattern Maker.

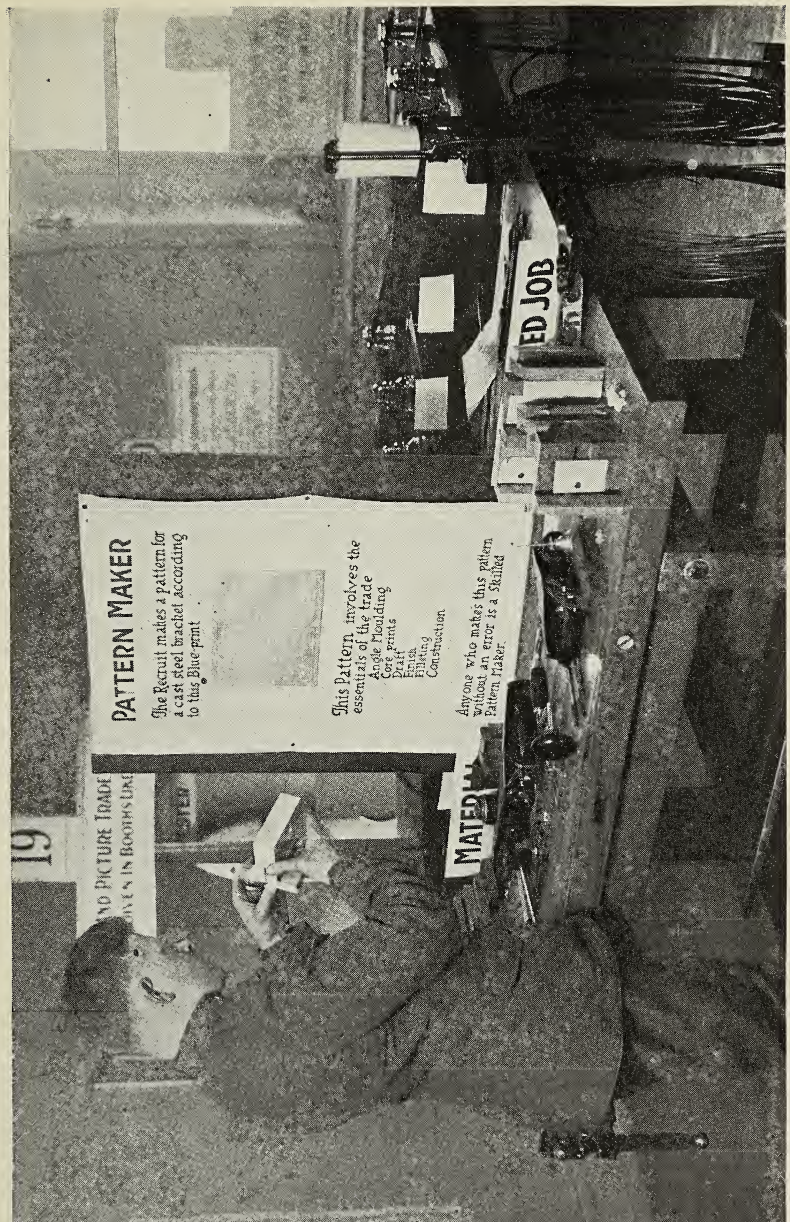

19
18
TRADE TESTS
PATTERN MAKER
The Recruit makes a pattern for a cast steel bracket according to this Blue-print
This Pattern involves the essentials of the trade
Angle Moulding
Core prints
Draft
Finish
Filleting
Construction
Anyone who makes this pattern without an error is a Skilled Pattern Maker.

Plate 28

The performance test for an Inside Wireman.

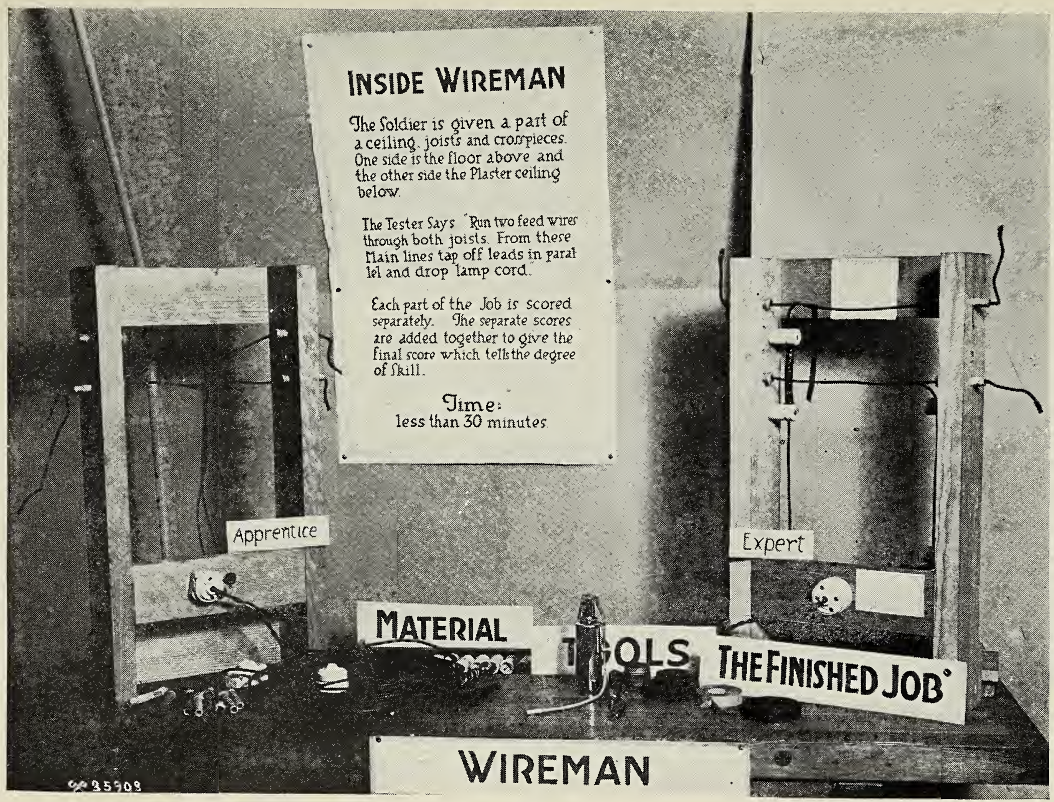

INSIDE WIREMAN
The Soldier is given a part of a ceiling, joists and crosspieces. One side is the floor above and the other side the Plaster ceiling below.
The Tester Says "Run two feed wires through both joists. From these Main lines tap off leads in parallel and drop lamp cord."
Each part of the Job is scored separately. The separate scores are added together to give the final score which tells the degree of Skill.
Time:
less than 30 minutes
Apprentice
Expert
MATERIAL
TOOLS
THE FINISHED JOB
WIREMAN
35308

Plate 29

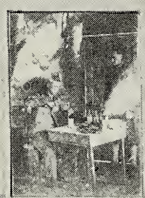
Pictures of some other Performance Tests.

250,000 SOLDIERS
HAVE BEEN TRADE TESTED

SOME PERFORMANCE TESTS

Auto Mechanic Assembling the Distributor

Auto Mechanic Fitting Gaskets and Packing Pump



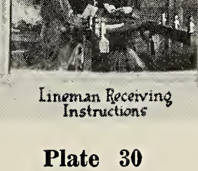
Auto Mechanic Repairing A Radiator

Auto Mechanic Cleaning the Idling Well

Electrician Wiring for An Electric Light

Sheet Metal Worker Rounding Pipe into Shape

Structural Steel Worker Cutting I Beam to Blue Print Specifications



Lineman Receiving Instructions

Plate 30

What Trade Tests show.


250,000
SOLDIERS
Have Been Trade Tested
Of Those Professing
Trade Ability
6 % are Expert
24% are Journeymen
40% are Apprentices
30% are Inexperienced
36341

Plate 31

How Trade Tests are made.

Steps In The Making Of A Trade Test

1st. Full information about the trade is gathered from:—
1 Labor Unions — 3 Trade Schools
2 Employers — 4 Trade Literature

2nd. A set of tentative questions, or a tentative job, embodying the essential features of the trade is prepared.

3rd. The tentative questions, or job, are tried out on a few tradesmen of differing degrees of trade ability.

4th. The test is revised in the light of the results of this trial.

5th. The test, as revised, is tried out on 20 men known to be Experts, 20 Journeymen, 20 Apprentices, and 20 Novices, (intelligent adults not trained to the trade). To avoid localisms tests are tried on men in Cleveland, Pittsburg, Newark and New York.

6th. Answers to questions, or jobs performed by the 80 men are analyzed to determine:—

In which questions, or features of the job, Experts do better than Journeymen, Journeymen better than Apprentices, Apprentices better than Novices

Which combinations of questions, or which job, will more accurately separate Experts from Journeymen, Journeymen from Apprentices, Apprentices from Novices.

7th. The finished trade test is prepared and sent to Trade Test Stations in various camps.

8th. Information is gathered from the camps and compiled pending future improvement of the test.

Plate 32

This Exhibit has briefly explained the Army Personnel Work—its principles, methods and results.

In 1917 and 1918 our cause demanded speed. Every day that could be saved from the period of training meant a day gained in putting troops at the front.

More than half of the men in the Army must be skilled at special trades in order to perform their military duties. To form the units quickly and at the same time supply them with the technical ability required, the Army had to avail itself of the trade knowledge and experience which the recruit brought with him from civil life. To discover this talent and assign it to those organizations where it was needed was the task of the Army Personnel Organization.

The Army could hardly have turned the tide to victory if it had been forced to train from the beginning any large proportion of the technical workers it needed. Every Combat Division requires 64 Mechanical Draftsmen, 63 Electricians, 142 Linemen, 10 Cable Splicers, 156 Radio Operators, 29 Switchboard Operators, 163 Telegraphers, 360 Telephone Repairmen, 52 Leather and Canvas Workers, 78 Surveyors, 40 Transitmen, 62 Topographers, 132 Auto Mechanics, 128 Machinists, 167 Mechanics, 67 Blacksmiths, 151 Carpenters, 691 Chauffeurs (auto and truck), 128 Tractor Operators, 122 Truckmasters.

Each Division had to have these specialists and men from 68 other trades among its enlisted men. Add to these the specialists required in the technical units of Engineers, Ordnance, Air Service, Signal Corps, Tanks, Motor Transport Corps and all the Services of Supply, and the impossibility of increasing an Army of 190,000 in March, 1917, to an Army of 3,665,000 in November, 1918, becomes apparent, unless every skilled man was used where skill was demanded.

These methods, borrowed largely from industry, in their application to the Army have been studied and developed to an unusual degree—owing to the urgency of the crisis and the unprecedented numbers of men affected. The improved methods developed by the Army will be found applicable to industrial personnel problems as well.

GENERAL HEADQUARTERS
OF THE ARMIES OF THE NORTH AND NORTHEAST

STAFF

STUDY AND EXPLOITATION
OF
AERIAL PHOTOGRAPHS

I. TEXT
II. PLATES

Issued by the Division of Military Aeronautics, U. S. Army

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

STUDY AND EXPLOITATION
OF
AERIAL PHOTOGRAPHS

INTRODUCTION.

The General Headquarters published, December 30, 1916, a volume entitled " Notes on the Interpretation of Aerial Photographs."

These "Notes" are no longer up to date and the object of the present work is to replace them. It has been compiled from a course of lectures at Chalons, December 1 to 15, 1917, in the presence of special officers from all the armies, who have contributed to it the results of their individual researches.

In this work are stated the principles governing the study of photographs and the duties of the different branches in charge of this study—" Second Bureaus " (Intelligence), Air Service, Artillery Information Service, Triangulation and Surveying Sections, Topographical and Map-making Sections.

It also treats of the different methods of studying photographs and includes all that has thus far been learned on this subject. It standardizes the principles regulating the organization and functions of the different photo-study sections. All instructions in regard to methods of photo-study are to be considered simply as suggestions.

This work will be supplemented by the periodical publication of pamphlets giving new information obtained since the publication of the preceding pamphlet.

FIRST PART.—PRINCIPLES.

CHAPTER I.

PRINCIPLES ON WHICH REST THE ORGANIZATION AND DEFENSE OF THE GERMAN POSITIONS.

Aerial photography originated with trench warfare. It made rapid progress and has become one of the most important sources of information at the commander's disposal. In fact, it alone makes possible the exact location of the enemy's defensive works and their detailed study.

The enemy, realizing its importance, tries to render this study difficult. Skillful camouflages, a large number of defenses and imitation works are some of the means employed.

As a result, the study of aerial photographs must be entrusted to specialists, who should be provided with all possible means of verification.

Of the indispensable kinds of information, the fundamental one is that of the defensive plans of the enemy. (The officers who will have to study, from the photos, the French defenses, must also be thoroughly conversant with our instructions of August 22, 1917, on field defenses, and the employment of all kinds of troops.) These principles are contained in the various rules and instructions emanating from the high command, especially the following:

Lessons drawn from the war, relating to field fortifications (June, 1915).

Lessons drawn from the battle of the Somme (June 24 to November 26, 1916), by the first German Army (Gen. F. von Below).

German regulations relating to stationary warfare for all arms (First part, Nov. 13 and Dec. 15, 1916; new edition, Aug. 17, 1917; eighth part, Dec. 1, 1916; appendix, June 10, 1917).

Lessons taught by the last battles at Verdun (G. H. Q., Dec. 25, 1916).

Orders of Gen. Sixt von Armin, commander of the Fourth Army, under date of June 30, 1917 (appendix to the B. R. of the G. H. Q. of the armies of the N. and N. E., of Sept. 13, 1917).

The reading of these documents enables one to understand the German operations since the beginning of stationary warfare, by following its evolutions. It simplifies its study and explains its reason.

It seems helpful to give a historical sketch of the principles of defensive fighting and of the working methods of our adversaries since the end of the year 1914.

PERIOD I.—END OF 1914 TO OCTOBER, 1915.

Originally, trenches were dug to protect the fighting line, after it had become stationary. Therefore they contained the larger part of the forces engaged. The supporting troops, smaller in numbers, sheltered themselves in other trenches a little further back.

This state of affairs continued for a year, *the fundamental principle* being that the first line trench should be held under all circumstances or retaken immediately, in case it should be penetrated by the enemy. (Instructions of Gen. von Below, commander of the Second Army, under date of August 1, 1915.) The period from the end of 1914 to October, 1915, was characterized by *the small depth of the German lines.*

By reference to photos (Pl. I) before November, 1915, it may be seen that the first line usually consisted of two continuous trenches. In front of these were barbed wire entanglements from 5 to 10 meters wide, preceded by numerous sentry posts. The trenches themselves were quite irregular, for protection against flank attacks. Sharpshooters were stationed at the firing notches. The communication trenches were from 2 to 4 meters wide. The regular trenches were narrow and not very deep (1.4 m., 1.8 m., occasionally 2 m., rarely 2.5 m.). Bomb-proof dugouts for the garrison were in the rear, but in immediate proximity to the first line trenches. They usually had two entrances opening from a circulation trench or boyau. The second trench was from 50 to 100 meters back of the first. It was also protected by barbed wire entanglements, and had dugouts for the supporting troops, whose number was about one-third as many as were in the first line.

Boyaus connected the first and second trenches, two for each company sector. Other boyaus communicated between the companies in line and the reserve troops, two or three boyaus for each battalion sector. The reserve troops lived in villages or camps, protected by trenches, and were often assigned the special rôle of "artillery protection."

Battery emplacements almost always consisted of plain earth breastworks connected with a boyau. Several casemates had, however, already appeared. The trenches were habitually protected against flanking by machine guns in the trenches themselves, with dugouts and protected firing platforms, and by several casemated guns in the first line.

Concrete first appeared in the spring of 1915, but it was generally used only for observation posts and flanking guns.

At least one or two kilometers back of the first line was the supporting line, usually with rather temporary defenses—one or two lines of trenches without dugouts or boyaus, but protected by barbed-wire entanglements.

PERIOD II.—OCTOBER, 1915, TO OCTOBER, 1916.

Photographs of the German defenses taken during the winter of 1915–1916 (Pl. II) show that important fortifications had been built along nearly the whole front. The experience acquired as a result of our September offensive had borne fruit. The lines had been reorganized, with reference to the three following points of view:

Economy of forces.
Reduction of losses.
Logical utilization of terrain.

Economy of forces was obtained by the depth arrangement. The first line no longer consisted of two trenches, but of three, all provided with dugouts. Back of this was an intermediate line, the line of artillery protection; farther back, a second line, consisting of two trenches with dugouts, one in front of the crest, the other on the opposite slope. (Redistribution of first line troops according to the Stein arrangement, in case of attack—Report Ia No. 1797 of Sept. 8, 1916—first line trenches, defense troops; second line trenches, defense and counteroffense troops; third line trenches, counteroffense troops.)

Reduction of losses was sought in:

(*a*) Deepening and widening the trenches—whence the disappearance of the circulation trenches and of the firing notches in unprotected terrains.
(*b*) Widening the communication trenches.
(*c*) Reenforcing the covered dugouts and especially in replacing them by underground dugouts.
(*d*) Building narrow-gauge railways (0.6 and 0.4 meters) to serve the front lines.
(*e*) Constructing casements to replace the old breastworks.

Utilization of the terrain was carefully studied for the purpose of an obstinate defense. They endeavored to render impossible the breaking of their lines, or at least to limit our progress beyond their first line by successive supporting lines, generally continuous oblique organized trenches or boyaus ("suspenders") connecting the first and second lines.

PERIOD III.—OCTOBER, 1916, TO JUNE, 1917.

After the hard battles of 1916 at Verdun and on the Somme, the German staff published, in November and December, 1916, "New Regulations for Stationary Warfare." The first part (General instructions on the organization of positions and the details of organization) and the eighth part of these regulations (Principles for conducting defensive battles) are of great interest.

A. The following are the *salient points:*

(*a*) Maximum utilization of the reverse slope.

(*b*) Organization of extensive fortified areas, several lines deep and thoroughly organized.

(*c*) Distribution on the terrain of flanking machine-guns (checkerboard arrangement) and dugouts forming the *skeleton of all the infantry fighting lines.*

(*d*) Successive lines of troops in depth.—Small garrison in the front line, with shallow concrete shelters so far as possible, the underground dugouts being reserved for the rear lines. (One about every 150 meters for a group of 8 men, on the Hindenburg line.)

(*e*) Extensive use of diagonal defensive trenches, especially near the sector limits.

(*f*) Execution of urgency works, picketing the lines, narrow-gauge railways, flanking sections and dugouts (position framework), observation posts, headquarters, auxiliary defenses, ammunition depots, drainage, etc.

B. Regarding *construction and organization details, the above-mentioned regulations recommend* (Pl. IV):

(*a*) Giving to the auxiliary defenses an irregular outline and arranging them in sections separated by spaces, in such fashion that they may be effectually flanked by machine guns.

(*b*) Still further widening the trenches and boyaus. (This width attains 3.2 and 3.4 meters on the Hindenburg line in front of the British.)

(*c*) To dispose the mortars outside of the firing trenches.

(*d*) To establish a large number of observation posts at successive intervals from the front.

It was in accordance with these principles that the Hindenburg line was constructed, during the winter of 1916–17.

PERIOD IV.—JUNE, 1917.

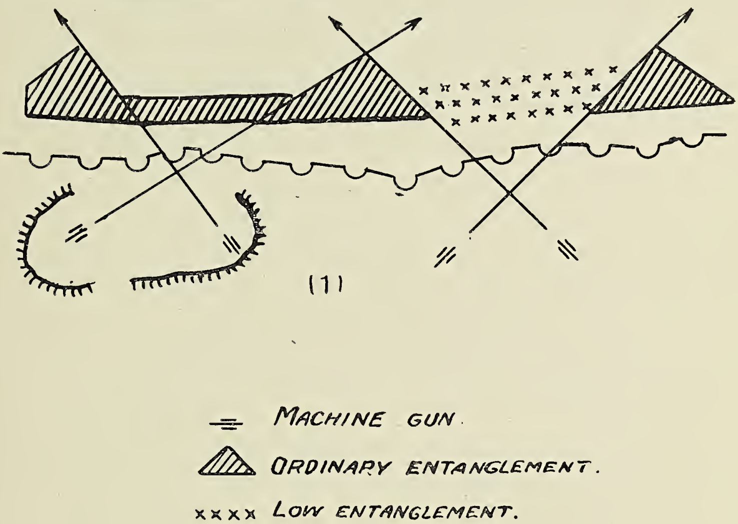
The French-English 1917 spring offensive led the German General Staff to publish, June 10, 1917, a Supplement to the Regulations for Stationary Warfare, in which were summarized the most important principles in these regulations.

This supplement was annotated and enlarged by Gen. Sixt von Armin (commander of the Fourth Army) in an *army order* under date of June 30, 1917. This order is certainly one of the most important documents that has fallen into our hands. Here are some essential extracts:

Necessity of camouflage (Pl. V, 2).—" Strength in a defensive battle depends *essentially* on the precautions taken to conceal from the eyes

of the enemy all our means of fighting. These fighting means (trenches, dugouts, machine-gun and battery emplacements) will *surely* be destroyed, if they appear on the enemy's *aerial photographs.*"

Depth organization.—"There must be substituted for the old system of position, which may be plotted and destroyed by the enemy, a defensive zone organized in depth."



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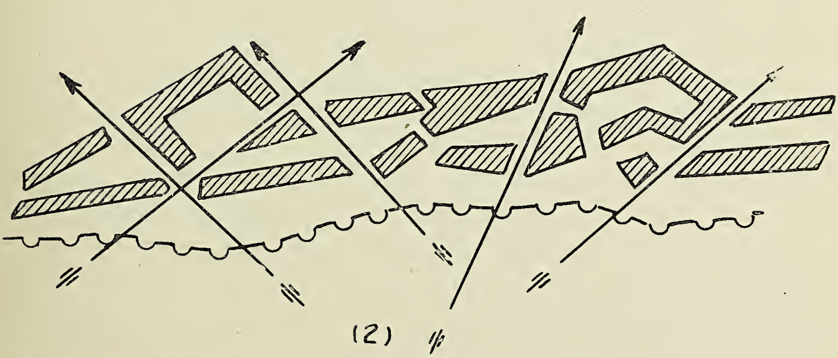


(2)

ENTANGLEMENT BROKEN TO PERMIT COUNTER ATTACK.

Utilization of shell holes by the fighting line.—"During a battle it is no longer necessary to have continuous trenches in the front line. They may be replaced by shell holes held by bunches of men and isolated machine guns, *arranged in checkerboard.*

"In front of the first row of shell holes will be placed an irregular barbed-wire entanglement, as continuous as possible. It is also ad-

visable to protect with barbed wire the holes in front of the first line, to prevent their occupation by the enemy.

"Farther back, it is preferable to organize isolated defensive works, by surrounding the shell holes with auxiliary defenses in such a way as to leave passages for counterattacking troops."

Placing supporting troops and reserves.—"A large part of the supporting troops and of the reserves will be sheltered in the open field, in shell holes, woods, ravines, anywhere to avoid aerial observation. (Villages must be avoided, as they draw the enemy's fire.) These troops assist in the formation of a continuous line, avoiding so far as possible the view of the enemy. Thus a supporting line is established for the defense troops placed at successive intervals in *front* of it."

First-line defenses.—"These must include several lines of trenches, protected by a strong barbed-wire entanglement, with passages for assaulting troops. Deep dugouts will be constructed only on the second and third lines. The first line will have only small dugouts, capable of holding about one-sixth of the occupants of this line."

New-line defenses.—"The organization of new lines back of the first will be governed by the same principles as above. If possible, the construction of dugouts for the garrison must be undertaken in succession for the whole depth of the zone. (For one-sixth of the men in the first trench, two-sixths in the second trench, three-sixths back of the second trench as far as the line of artillery defense.)

"By the creation of numerous shelters in the rear of the lines, preparations are made for the opening of the defensive battle, the orderly retreat of the troops in the trenches, and their redistribution on the intermediate terrain.

Order of urgency of the works (Pl. V, 1).—"Staking out the works, placing auxiliary defenses, bomb-proof shelters, digging trenches."

Machine-gun emplacements.—"Machine-gun locations should not be chosen in front positions, but on the sides of hills or in depressions, at points convenient for flanking. The enemy should come upon machine guns unexpectedly. Therefore, it is not desirable to install them in salients, but to the right or left or in the rear. In the salients only fake emplacements should be constructed."

Laying out boyaus.—"In order to prevent the enemy from forming an exact idea of our system of defense, the boyaus connecting the different lines may be given an oblique direction. This arrangement gives the appearance of the meshes of a net, in which the boyaus, provided with auxiliary defenses and organized as firing trenches, have at the same time defensive functions. (Riegel.)

"Everywhere must be kept in mind the necessity of escaping aerial observation."

PERIOD V.—AUGUST, 1917.

The supplement of June 10, 1917, appeared a little in advance of a new edition of the First Part (Section A) of the Regulations for Stationary Warfare, which reaffirmed the necessity, for all defensive works, of organization in depth for a mobile and active defense.

Fighting zones.—But where, in the appendix of June 10, 1917, it was written: "The fight in or for the first line has become the fight for the first position," the new regulation reads: "*The fight must be conducted not about the lines, but in the fighting zones.*"

The fighting zone comprises a number of organizations (trenches, boyaus, supporting points, etc.) designated to provide for the *defense* by infantry and artillery, *lines of communication*, *replenishment* and *good conditions of living.* Its depth could reach several kilometers. Its defense was to be organized by sectors.

Several fighting zones will be constructed, at least 3 km. from each other so that artillery preparation can not be made on two zones at the same time. A fighting zone should include:

(*a*) An *ordinary fighting zone*, organized to repel any surprise attack and considered as the covering zone (Vorfeld-zone).

(*b*) A *grand fighting zone* (Grosskampfzone). It is in this that enemy attacks, even the most violent, must be stopped. It may coincide with the ordinary fighting zone. If, however, the latter zone is unfavorably located, the grand fighting zone will be located and organized further back. The grand fighting zone should be constructed in the ordinary fighting zone but with much more care and thoroughness. Still further back, at least one rear fighting zone (Rueckwaertige Kampfzone).

The principles already stated for selecting trench locations also apply to selecting zone locations:

Need of good rear communications,
Need of good artillery observation,
For trenches, the use of opposite slope, wherever compatible with good artillery observation.

Location of batteries.—The regulations of August 17 insist upon the necessity of making shelters for the men, munitions and artillery. Mobility being the best protection against enemy fire, it prescribes the organization, in advance, of extra emplacements with dugouts. It goes even further, and this is new, in saying that "during a battle, or for special objects, the use of unprepared locations is often advisable."

Order of Urgency of Defensive Works.—The order of urgency of the works has not been changed: flanking positions and dugouts, ob-

servation stations and headquarters, barbed wire entanglements, communications (liaisons). Earthworks (terrassements) are only made as a last extremity.

The historical sketch, just given, shows the evolution of the German theory of defense. The fighting *in or for the first line* has become the fight *in the fighting zone.* This doctrine may be modified in the future.

Whatever changes may be made, it is probable that aerial photos and information from prisoners, observation stations, etc., will enable us to keep pace with them. Perhaps the difficulties encountered by the officers who have to interpret the photos will become greater. They will always be less than those of our adversary to conceal his system of defense.

CHAPTER II.

STUDY OF AERIAL PHOTOGRAPHS.

The complete study of aerial photos comprises three distinct operations: *interpretation*, *restitution*, *exploitation.*

1. *Interpretation* has for its object to determine the nature and importance of the works and various elements of the enemy organization, visible on the photos.

Officers skilled in the interpretation of photos, however great their experience in this kind of work, often find it impossible to determine the nature and especially the exact object of enemy works, without information from other sources (questioning prisoners, etc.).

It is then only through the Second Bureau, central organ of enemy information, that the definite interpretation of the photos can be made. But all officers who receive the photos should study and try to interpret them.

2. *Restitution* consists in locating exactly the figures more or less obscured on the photo, especially enemy organizations. This process is distinct from interpretation, but restitution necessitates interpretation, more or less provisional, since it permits the adoption of a conventional sign.

Precise and *definite restitution* enters into the work of the triangulation and surveying sections, in charge of making directive charts.

Provisional restitution enters into the work of the topographic sections of the army corps, designed to assure the production of the directive charts. (See instructions on directive charts.) It is to be noted in any case that the topographical section, aside from this provisional restitution, has to make the *study map* of the enemy front lines on the scale of 1:10000.

3. *Exploitation.*—Interpretation and restitution are indispensable, but they are not enough. The commander, in fact, needs to know not only the location, nature, importance, and details of enemy works, but also why they have been constructed and the purposes they are intended to serve. This last study is of the *tactical order.* It consists in analyzing the enemy defense or in discovering his intentions of atacking, while taking account of his fighting methods. This is *exploitation* and devolves upon the staffs (Second Bureau). It enables the intelligent planning of operations and of artillery action.

Exploitation is possible, since our adversaries make use of it. It is from the plan of defense, in fact, that all the enemy works evolve. The larger part of these works are known to us, either from photos or other sources (Second Bureaus). It is, therefore, only a matter of assembling the known data and all other obtainable information and deducing from them the whole plan.

How shall we proceed in order to arrive at this result? It is first necessary to thoroughly study the terrain on which the enemy intends to make his stand. (Use may be advantageously made of short-focus stereoscopic views.) It is then necessary to construct, for their whole depth, the sectors of the division and, for each division, the regiment, battalion, and company sectors. This work will be facilitated by what is already known of the occupation of the sectors, of their limits in the first line (regiments, battalions, companies), of the successive troop formations in depth, of rest camps, etc., according to information collected by the Second Bureaus.

After the sectors have been once defined (Pl. VI), there will be studied, for each one, the distribution of troops of defense (garrisons, supporting troops, reserves) and the centers of resistance will be indicated.

There will then remain to be determined, from what is known of the terrain and the roads, the probable routes by which the reserves will intervene.

The study of the defense must not be confined to the front lines but must be followed to the rear. There will be need, in fact, of anticipating the entrance into the lines of divisional *reserves* and even of *reinforcing divisions* charged with carrying out sustained counterattacks. All shelters, camps, roads, observation stations and battery emplacements of the rear zone should therefore be given the closest attention.

The enemy works must be closely followed. According to their nature, they will denote the *defensive* or *offensive* plans of the enemy. Artillery changes of position, with resulting new arrangements, and the appearance of an unusual number of mortar emplacements may presage a local attack. As for indications foretelling large offensive operations, it is usually in the rear zone that they are first

discovered. Among these indications there have, up to the present time, been noted in their order of succession:

(*a*) Strengthening of anti-airplane defense.

(*b*) Construction of new roads, of ordinary and narrow-gauge railways, camps, etc.

(*c*) Appearance of new battery emplacements.

(*d*) Appearance of new infantry works, dugouts, boyaus, mortar emplacements.

(*e*) Shrinking of the sectors.

All information gathered from the study of aerial photos must be marked on maps or charts or written out and distributed to all sections that keep a *sector album*, so that it may be constantly accessible. (This album must contain in particular all vertical and oblique photos, of both French and German organizations, of interest to the sectors.) It is inadmissible that any sector album should not permanently contain all known information about the enemy. It must nevertheless be admitted that, as regards enemy defenses, this information has unfortunately often been inadequate.

Aerial photographs, so valuable during the period of preparation, are none the less so *during the course of the battle*. They facilitate destruction of enemy defenses and make it possible to follow, in the zone of shell holes, the progress of our infantry, to locate the enemy's front line, his new defenses and successive lines of support, reserves and battery emplacements, all of which information is valuable to the commander and troops, and which is transmitted to them in the form of corrections on the directing plans or special charts.

During a battle the photos must be studied every day as fast as they are brought in. It is important to work fast, so as not to delay the making of corrections or new sketches. It is the duty of the Second Bureau chiefs to distribute the work among the various specialists.

CHAPTER III.

AERIAL PHOTO STUDY SECTIONS AND RELATIONS BETWEEN THE SECTIONS.

The chief of the Second Bureau (Army and Army Corps) establishes the *plan of research* in accordance with which the photo missions are assigned to the Air Service. This plan of research takes account of the opinions expressed by the Third Bureau, the Artillery Section, the Air Service, and the commanders of the large subordinate units.

Photos taken by the squadrons are interpreted by the various photo study sections (Second Bureaus, Air, Artillery, Triangulation). The

Triangulation and Topographic Sections make the final or provisional *restitution* and make information maps and charts by the aid of the data furnished them by the Second Bureaus upon which devolves the duty of determining the final interpretation to be recorded on the maps or plans. (See Instructions on "Directing plans, maps, and special charts" of Nov. 20, 1917.)

The contributions, as regards photo study, of the various sections enumerated above may be summarized as follows:

1. ARMY.

A. *Second Bureau.*—On account of the importance which the search for information by the examination of aerial photos has assumed in the Second Bureau, it is necessary that several officers of the bureau should be capable of interpreting them. The distribution of the work may be, for example, as follows:

One of these officers, specially qualified, has charge of the work done by the Second Bureaus of the army corps and makes a thorough study of the enemy rear zone (supporting lines, communications, bombardment targets, military establishments, etc.). He receives from the officer of the bureau, who is occupied with artillery problems and who studies aerial photos with reference to its special needs, all information of interest to him. He communicates his conclusions to the Chief of the Second Bureau who determines the final interpretation to give the photos. This is transmitted to the Triangulation Section.

On the other hand, as regards the batteries and important objectives of the artillery, the interpretation of the photos is made at a conference attended by:

The officer of Second Bureau in charge of artillery,
The officer of the Artillery Information Section,
A representative of the Air Service,
A representative of the Triangulation Section,

or after an understanding with them. It is submitted for the approval of the Chief of the Second Bureau.

B. *Air Information Section.*—The Air Section, in sending to the Artillery Information Section and to the Triangulation Section a copy of each photo, attaches to it its own individual interpretation. This interpretation is made, under the direction of the tactical assistant, by the information officer and the officer in charge of photography, assisted by the officer observers. It is indicated on the photos or on charts. (Independently of the interpretation, the Air Information Section furnishes the Air Division the special works required of it.)

On the photos, new works, interesting points, destructions, etc., are encircled with red ink, but not written over. The nature of the works is indicated by a mark followed by interrogation point, if doubtful. The charts are accompanied by a brief explanatory note or index.

The tactical assistant, the officer of Air Information, or even the officer who took the photos, are called, whenever necessary, to conferences where, under the direction of the Chief of the Second Bureau, the final interpretation of the photos is made.

C.—*Artillery Information Section.*—The Artillery Information Section receives from the Air Division the photos interpreted as already stated. It also makes a thorough study of these photos, with reference to batteries and related elements and particularly important objectives (camps, bridges, railway stations, munition depots, etc.).

It reviews the work of the Artillery Information Sections of the Army Corps and harmonizes them with each other. It makes direct use of these works, but makes them more definite by comparison and by using any new information in his possession. In this manner he effects for the whole Army front final decisions which serve as a basis for the later work of the Army Corps.

The interpretation of photos in regard to batteries and important artillery objectives is not definitely determined until after the approval of the Second Bureau chief. This is what goes on the directing plan.

On the other hand, the Artillery Information Section also studies the firing of the French batteries, after their results appear on the photos.

D.—*Triangulation Section.*—The final restitutions of photos, shown on the editions of the Directing Plan, are made by the Triangulation Section and under its responsibility. It takes account of everything known about the enemy defenses. For this purpose it receives from the Second Bureaus of the Army and Army Corps the necessary documents and information, including the works of the Topographic Section of the Army Corps. It changes, if necessary, the provisional interpretation adopted for the restitution, in order to make it conform with the final interpretation approved by the Chief of the Second Bureau.

2. ARMY CORPS.

The photo study of the Army Corps is made on the same principles by the Second Bureau, Air Information Section, Artillery Information Section, and Topographic Section of Army Corps.

A.—*Second Bureau.*—The Second Bureau of the Army Corps has a special officer for studying aerial photos. This officer himself studies the photos with the greatest care, while making use of the interpretation given them by the Information Section of the aerial section. He controls, in this respect, the batteries served by the Artillery Information Section and furnishes to the Topographic Section of Army Corps the information necessary or making maps and charts. He keeps in constant touch with the Artillery Information Section and the Air Information Section.

In addition to the *interpretation*, the special officer must also attend to the *exploitation* of the photos, as set forth in Chapter II. He transmits his conclusions to his bureau chief. The latter is alone responsible, under the Chief of Staff, for the Information Service. No document may be taken out and distributed without his order.

Periodic conferences.—It is necessary for all officers, contributing to the study of photos (air information officer and observers, if necessary; officer of Artillery Information Section; Chief of Topographic Section of Army Corps), to hold periodic conferences under the direction of the Chief of the Second Bureau.

In ordinary times these conferences may take place at variable intervals. But *during a battle* they will be held daily (so far as possible) and usually on the landing field of the sector.

B. *Air Information Section.*—The information officer of the air sector supervises the interpretation of the photos, in which all the observers assist, the artillery observers giving their special attention to searching out the batteries. The results are brought to the knowledge of the Second Bureaus and Artillery Information Sections by means of sketches or photos treated as already specified for the Army.

C.—*Artillery Information Section.*—The Artillery Information Section, Second Bureau, and Air Information Section must keep constantly in touch with one another. They communicate to each other all the information they have concerning artillery objectives. The Artillery Information Section studies the aerial photos, collects and compares all information and goes over it first with all possible pains, but also with the care not to delay its transmission to the interested parties so that they may be able to make use of it at the right time. The battery emplacements and artillery objectives revealed by photography are determined after examination in common by a representative of the Second Bureau, of the Air Service, and of the Artillery Information Section and on the responsibility of the Second Bureau.

D.—*Topographic Section of Army Corps.*—The Topographic Section of Army Corps makes a *provisional restitution* of the photos,

the interpretation of which is transmitted to it by the Second Bureau. It can not print any document without the approval of the chief of the Second Bureau, delegated by the Chief of Staff.

3. DIVISION.

On the Staff of the Division there must be an officer whose special duty is to study on the aerial photos the enemy first line organizations. This officer will keep account of all information furnished by the troops in the sector. He will keep in constant touch with the information officers of the troop corps. If an air squadron is assigned especially to one division, it will be advantageous to hold a daily conference on the landing field the same as in an army corps.

4. RÔLE OF "SPECIAL OFFICERS" AS INSTRUCTORS.

The *interpretation* of aerial photos is a very special work, requiring quite a long apprenticeship and much personal work. It is indispensable to profit from the experience acquired. It is for this purpose that this treatise is accompanied by many characteristic examples of enemy works. It is one of the duties of the special officers to finish the instruction of those of their comrades who, in the subordinate units of their organization, assist in the interpretation of the photos. They must also endeavor to popularize the interpretation of photos among the information officers of the infantry and artillery corps.

It devolves upon the Second Bureaus to give the necessary impetus and to coordinate the efforts of the various sections, whose duty is to mutually assist each other (Artillery Information Section, Air Information Section, Triangulation Section, and Topographic Section of Army Corps).

CHAPTER IV.

GENERAL METHODS OF STUDYING AERIAL PHOTOGRAPHS.

1. TYPES OF AERIAL PHOTOGRAPHS.

There are three types of aerial photos:

1. *Panoramic* (Pl. VII, 1 and 2), showing the whole sector as far as the horizon (general form of terrain, trench lines, roads, etc.).

2. *Oblique* (Pl. VII, 3), taken at low altitude, with long-focus camera, and covering only a small area. They help to show differences of level, banks of earth, sunken roads, etc., battlements and

other works which elude vertical observation. They are valuable for the information of attacking infantry (Pl. VII). In certain cases oblique photos (Pl. IX) should be taken from the *rear*, in order to show the details of a parapet (dugout entrances, gas installations, etc.), and hillside defenses, hidden from ground view.

3. *Vertical*, showing, acording to the altitude and the focus of camera (that is, according to the *scale*), more or less of the details.

A request for photos should always specify the point or region and the scale. All latitude is thus left to the photographer to select his airplane and determine the altitude at which he will operate.

It is well to remember the importance of photos taken after a snowstorm for studying trails, barbed-wire entanglements, camouflages, shelters.

2. METHODS OF STUDYING AERIAL PHOTOGRAPHS.

In general one should not be content with studying the last photos taken. He should, on the contrary, constantly compare recent photos with previous ones, even very old, for the purpose of discovering slight, but often significant, changes.

The interpretation is, in fact, based on the study of appearance and form, shadows and relief. It is necessary to apply to this study scientific methods and painstaking attention to details, to remember that the *whole* surface of a photo must be gone over in a logical order, but to distrust and control one's imagination so far as possible.

A. *Study of whole sector.*—May be made:

(*a*) On panoramic or oblique photos (sometimes stereoscopic), completed by—

(*b*) Assemblages of vertical photos, sometimes distributed in the form of photos or phototypes of assemblages.

B. *Study of details.*—Always done on vertical photos (supplemented in some cases by oblique photos).

(*a*) *With a magnifying glass* (pl. X), taking care to illuminate the photo in such a way as to give a correct impression of the reliefs. For this purpose, turn the photo so as to bring the source of light (window, lamp) in the direction that the object was when the photo was taken. In this way, the real meaning is given to the shadows, making it possible to distinguish the reliefs from the depressions and estimate the heighth or depth of objects by comparison with the length of the shadows of known objects. For studying certain details, it will be necessary to have photos taken at a given hour.

(*b*) *By stereoscope examination*, using ordinary stereoscopes, if one has prepared stereoscopic views at his disposal. Binoculars with variable separation for all photos taken at the same altitude and the same hour.* The Schweisguth panstereoscope.

* METHOD: (1) Superpose the common parts of the two photos. (2) Find line connecting centers of the two photos (prick with pin, if necessary). (3) Keep this line continuous. (4) Separate the two photos on above line to a distance equal to that between the eyes. (5) Place the binoculars (adjusted as to separation) upon the photos, parallel to line of centers, with parts to be studied arranged symmetrically in the two eyepieces. (6) Place the eyes on the binoculars and raise them until the two images (at first seen separately) resolve into one, giving effect of relief.

If, when performing operation 5, the point to be studied on one of photos is covered by the other, cut the gelatine film with a knife (in order not to destroy the photo), on a line perpendicular to the line of the centers, and turn the edge under.

Most stereoscopic views give an exaggerated relief on account of the great separation of the bases, but even this exaggeration is useful for estimating reliefs of very small magnitude.

3. FUNCTION OF AERIAL PHOTOGRAPHY—RELATION TO OTHER SOURCES OF INFORMATION.

Aerial photos are not the only source of information. The interpretation of photos must be verified and supplemented by other sources of information. Inversely, photos are necessary for the various investigating sections in order to direct their researches and govern or explain their information. This double relation of photography with other sources is explained below.

A.—*Questioning prisoners and deserters.*—(*a*) In a general way, it is necessary to verify the interpretation of photos as often as possible by interrogatories. Furthermore, photos whose interpretation is doubtful (new works, camouflages, etc.) should be laid aside, awaiting the possibility of verification. It is, therefore, necessary that all engaged in study of photos should be present at the interrogatories, or have questions asked in regard to what interests them.

(*b*) Independently of these particular points, an interrogatory will not be complete and fruitful, unless it has been carefully prepared on photos of sector known to prisoner. The interpreters should be trained in reading aerial photos.

It is to be recommended that the photos of the sector should be arranged from the rear to the front trench, in order to follow the prisoner's itinerary with him, for this is the guiding thread for locating the other information. Details (isolated tree, house, etc.), which have attracted his attention, are generally the landmarks

visible on the photos. An interrogatory thus conducted should specify, for example:

Debarking station: Platforms, switches, rolling stock.
Itinerary: Roads, trails.
Rest camps: Location (difficult to discover in woods) capacity.
Replenishing center, distribution center.
Narrow-gauge railways encountered.
Headquarters of captain and battalion chief, sometimes of colonel.
Dugouts: Their type.
Machine guns of sector.
Limits of sector.
Distribution of units in the lines.
Orders in case of alarm, permitting discovery of supporting points, etc.

(If the prisoner is an artilleryman:)

Location of his battery and other batteries of group, and description.
Observation station or stations.
Distribution of troops (echelons), etc.

All information obtained in course of interrogatory, especially concerning the lines, must be immediately verified on long-focus vertical photos. Moreover, this will be a means of verifying, in regard to visible and indisputable points, the accuracy of the answers and the degree of credence to accord the prisoner.

Lastly, for everything not visible on the photos (organizations in woods, tunnels, mines, etc.) the interrogatories are the only source of information.

B. *Information from repatriated persons.*—It concerns especially the immediate rear, sometimes making it possible to explain certain points, but should always be verified by photos.

C. *Contact information.*—This is collected by the information officers of the regiments and comes from two principal sources—patrols and infantry observers.

(*a*) They *supplement* the photos in regard to arrangement and occupation of shell holes, importance of barbed-wire entanglements.

Designate:

Observation posts.
Machine-gun emplacements and firing directions.

Suggest: Researches, to discover cause of certain noises.

(*b*) Vertical and oblique photos are useful to information officers in *locating exactly* the various things observed, especially:

Machine guns (firing direction not always known).
Mortars (concealed).

Smoke in cold weather (occupied dugouts).

Frequented trails (whose concealed prolongations can only be known by photos).

Works, whose location is indefinite or betrayed only by the noise.

Narrow-gauge railways, betrayed by rolling of cars.

Reading photos may cause certain officers to make deductions. The bare facts, nevertheless, must always be transmitted for the decision of the special interpreter.

D. *Observation stations.*—Information Section of Field Observations.—Section of Spotting by Sound.

(*A*) *General information.*

(*a*) Observation stations and S. R. O. T. can locate:

Enemy observation stations.

Visual telegraphy stations.

Obscure telephone lines.

Travel on roads or trails, importance and nature (infantry or artillery).

Railroads: existence (if doubtful) and gauge (1.6 m. or 1.4 m.).

(*b*) Assemblages of vertical photos enable:

Location, for example, of—

Visual signals, train smoke.

Explanation of—

Suspected works, camouflages, masks.

Completion, in regard to concealed parts of panoramic view, of—

Observations, especially railway extensions, telephone lines, etc.

(*B*) *Artillery information.*

(*a*) Due to their means of spotting, the Artillery Information Section can *say:*

What suspected point (in a woods, for example) is a battery.

What battery is active.

And *suggest:*

New investigations or photo missions, in region where new battery appears.

(*b*) For very visible batteries, the photos *designate:*

Location, number of casemates, often their protection, etc.

Old photo collections are always valuable for reference.

E. *Balloons.*—A balloon may be attached to an elevated ground observatory, for distant views.

F. *Airplanes* (*a*) can give all information relating to roads of communication and travel on the highways or railroads.

(*b*) Photos are used by the observers for studying the terrain. They must have a detailed knowledge of their sector, enabling them to notice immediately anything new or suspicious (in order to have it photographed), to follow the phases of a bombardment, of an artillery preparation, or an infantry advance.

G. *Documents.*—(*a*) The interpretation is perfect, if the photos have been made on same day as document. The best sketches must be carefully inspected, for they often contain notations of machine guns, mortars, fake works, and plans.

(*b*) In the case of unidentified sketches, photos facilitate the identification better than a directing plan.

H. *Radio.*—Since radio liaison accompanies most of the other liaison methods, the determination of posts by radiogonometric intersection permits the localizing of the regions of headquarters and contributes to their discovery.

SECOND PART.—ORGANIZATION OF INFANTRY, PIONEERS AND SUPERIOR COMMAND.

PERIOD I.—BEFORE THE BATTLE.

The principles governing construction of new positions and transformation of the old have been explained in the first part, as also the general methods which must govern the study and interpretation of photos.

All the work depends on the *identification* and *estimation* of a certain number of *simple elements*, which are found over the whole organized terrain from the fighting lines to the reserve and supporting lines.

This work requires, on the one hand, *well trained eyes*, which can be acquired by examining the attached photos, whose interpretation is largely confirmed by documents. On the other hand, a perfect knowledge of details of organization, found in " German Regulations for Stationary Warfare " (Translated by G. H. Q., Second Bureau, or S. T. G.) and in various other documents.

The following notes are only an explanation of methods and a résumé of information, which may be obtained from the interpretation of the photos. One will first analyze the various elements of a defensive system, beginning with the first indications of organization (barbed wire entanglements, machine guns, dugouts), then the lines connecting them (resistance centers, supporting lines, disposition of reserves, etc.).

CHAPTER I.

STUDY OF DETAILS.

1. ACCESSORY DEFENSES.

These are barbed wire entanglements, chevaux de frise, and abatis. Loop holes have disappeared.

A. *Barbed wire.*—The appearance of the entanglements, modified since 1916, varies greatly. There are found:

Two or more parallel entanglements, often in compartments (Pl. XI, 1 and LVI, 1).

Entanglements of geometrical form (triangle, trapezoid) (Pl. IV).

Saw-teeth entanglements (Pl. XV, 2).

Curved entanglements (Pl. XI, 2).

Very short entanglements, not parallel to the lines.

The entanglements are placed in front of the trenches, along certain boyaus, about closed works or centers of resistance, about batteries and reserve emplacements, rarely about a solitary machine gun, often back between the lines. In the latter case it is either the beginning of a new line or a protection for machine guns, which must then be sought for.

The dominating feature of the counter-attack is the placing of large visible obstacles. (See Order of the 183d Div. R. of July 13, 1917.)

It is almost impossible to discover entanglements in woods, excepting on snow photos.

One must look out for imitation entanglements, consisting of rows of holes, but without iron wires and often without stakes. Obstacles are likewise faked by stakes without wires, the appearance only differing slightly from the rest of the system (Pl. XI, 2).

The width of an entanglement may be measured. Its height can only be estimated on the best photos, but the deficiency can be supplied by contact information.

B. *Chevaux de frise.*—These are found especially in old organizations, or near the obstacles of new defenses. Their appearance is characteristic.

C. *Abatis.*—On large-scale photos are seen the trees cut down on the enemy side.

2. MACHINE GUNS.

The search for machine guns is constantly growing more difficult. In the trenches, the blockhouses with visible loopholes have been mostly discontinued. The machine guns are in the dugouts and are placed, at the time of the battle, on parapets in locations generally planned, but with a few in the trenches. (Pl. XVI, 2, and XII, 1.) Outside of the trenches, the search is perhaps easier, but on account of the scattering of the guns, it remains quite difficult and requires a detailed study of the whole field. (Regulations of Nov. 13, 1916, Par. 6; Appendix of June 10, 1917, Par. 7; Lessons learned from the Battle of the Aisne (43rd D. R.) of May 10, 1917.)

The various aspects of a machine gun emplacement are:

(*a*) Niche in the parapet of a trench or boyau, or a small platform.

(*b*) Blockhouse without loophole, but with a periscope hole and with a machine gun platform in the rear.

(*c*) Hole in front of firing line, at end of covered boyau.

(*d*) Concrete blockhouse, between the lines, concealed by a hedge, in a farm building, etc. (Pl. XII, 4.)

(*e*) Isolated crossing, between two short trenches (with dugout).

(*f*) Square holes (pit openings, often in pairs, concealed by camouflage, with or without visible dirt piles). Sometimes a path or narrow-gauge railway leads to a distant dirt pile.

(*g*) Shell holes, real or artificial, with notches on the edge (sometimes with auxiliary holes for the grenade throwers).

Emplacements outside of trenches are revealed by small paths, barbed wire obstructions and appearance of ground and dirt piles.

The methodical search must depend for its basis upon a thorough knowledge of the field (acquired not from the directing plan, but from stereoscopic photos), and be guided by the barbed wire entanglements, whose opening and obstructions are always defended by machine guns (See Wytschæte's grouping orders of Sept. 5, 1917). Low entanglements are a sure indication. Machine guns are also found where there are no entanglements.

A certain number of emplacements are absolutely characteristic. Others may be considered as probable, if they have a firing field of 100 meters, if a dugout is in the vicinity.

Lastly, it is necessary to look out for false emplacements, especially numerous in the entanglements and trenches.

Information from patrols and prisoners is valuable in searching for machine guns.

3. SHELTERS.

Shelters are of two types:

(*a*) Concrete or wood and iron.

(*b*) Underground galleries or *dugouts*. (For details of construction see regulations of Dec. 5, 1916.)

(*a*) Concrete shelters (Pls. XVI and XVII) are numerous in front trenches of recent construction, but photos of lines in course of construction show some in the rear and even outside of the trenches. In old organizations concrete shelters were made in the front-line trenches for observation or listening posts and machine guns. In Flanders these constructions are arranged in depth (échelonnés) along roads and in farmhouses.

(*b*) Underground galleries (or dugouts) follow the usual rule (Pl. XV). In accordance with the orders of the German superior command they are seldom located in the fighting trenches. They are at present from 6 to 10 meters deep.

The indications assisting the discovery of shelters and their type are:

A. *During construction* (Pls. XXXII and XXXIII):

(*a*) Excavations and dirt heaps. Excavations, often concealed by camouflage, indicate concrete shelters with the dirt spread out about the hole or removed several meters to the rear, forming large heaps, or carried to some distance on a narrow-gauge railway. The dirt piles of the underground dugouts are generally around two entrances (black spots visible at the beginning of the work).

(*b*) The narrow-gauge railway.

B. *After construction:*

(*a*) Traces of entrances (shadow or small notch in the parapet or bank). Usually the entrances of the concrete type are between two traverses, sometimes with an entrance on either side of a traverse.

(*b*) Ventilating shafts.

(*c*) Narrow-gauge railway, which was used for bringing the concrete materials.

(*d*) Piles of dirt and sometimes the trails made in removing it.

Examination of photos may furnish the following information in addition to their location:

Their type (concrete or underground dugout) and their defenses. Their size, according to the quantity of dirt. Their entrances, sometimes auxiliary outlets. Their near defenses. After a snowstorm, the melting of the snow reveals the occupied dugouts. (Pl. XVII, 3.)

Lastly, their purpose may be determined in a large number of cases (habitation, observation, machine gun, headquarters, etc.).

4. SHELL-HOLE DEFENSES.

The defenses of the battle field will be studied further along. (See p. 30.) In certain sectors (supporting lines north of Ailete, lines south of Somme-Py, etc.; on the English front there are large organizations of artificial shell holes) back of the lines or between them are found quite extensive defenses of shell holes. (Pl. XVIII, 1–2.) There are two distinct forms:

(*a*) Shell holes, real or artificial, arranged at intervals from the front or in quincunx, encircling the machine-gun emplacement outside the trenches, mentioned on a preceding page.

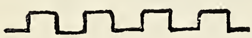
(*b*) Holes, often squares, which seem to be shallow and are arranged in pairs.

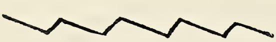
These organizations, which can be studied only on large-scale photos, are revealed (1) by the dirt piles, sometimes spread out in the neighboring holes; (2) by the arrangement itself; (3) by material (wood) left in or near the holes; (4) by a dugout entrance visible at the bottom; (5) by the beginning of a boyau, extended underground. Many of the holes are camouflaged.

5. TRENCHES.

The shape of the trenches is as varied as the appearance of the barbed-wire obstructions. Pls. XVIII, 3, XIX, and XXXII, 1.)

Aside from the old trenches, with narrow traverses or none at all (active sectors frequently upset), the dominating type is the trench with very wide traverses (6 to 8 meters). The other forms are:





The profile has also been modified and the trenches have been widened (Pl. XVIII, 3, and Pl. XIX). In a certain number of new positions are found, in one part or another of the boyaus, short trenches which do not form a continuous line. This disposition is according to a plan of subdivision into compartments. (See Wytschaete's grouping orders of Sept. 5, 1917.)

The firing step exists even in the rear of the broad cross-trenches. The gunner's niche only appears rarely.

One must look out for imitation trenches which are only 40 to 50 centimeters deep and sometimes are only tracings. The depth can be estimated only by a study of the shadows. (Pl. XXVIII, 1.)

The cesspools and latrines are small rectangular holes at the end of short boyaus. In front of the trenches, in the entanglements, the sentinels' pits are connected with the trench by a short path or covered boyau.

6. TRENCH MORTARS (MINENWERFER).

(See Trench Mortar Regulations of July 1, 1917; part 7 of Rules of Stationary Warfare.)

Light mortars are not usually covered, while medium and heavy ones are in protected emplacements. The latest regulations recommended not to increase the covered emplacements, but to prepare many extra ones open to the sky. (Pl. LVII, 1 and 2.)

Protected emplacements are located either in front of a firing trench, on the side of a boyau, or between the trenches, frequently

in groups of two or four. The indications (Pl. XX), enabling them to be found, are:

(*a*) Small boyaus ending in them (boyaus with elbows or jogs, covered boyaus not connected with a trench).

(*b*) Paths connecting the emplacement with a narrow-gauge railway, an advanced observation post, etc.

(*c*) Dirt piles, indicating a dugout, in the middle of which is visible the exit for the projectile. This hole, square or rectangular, is often camouflaged.

Contact information alone can determine which emplacements are occupied.

7. LOCATIONS OF RESERVES.

It is necessary to distinguish between reserves *ready for action*, located immediately back of the fighting line or near the second line, and the *resting* reserves, located in the rear.

A. *Supporting troops* are disposed (Pls. XXI, and XXVIII, 2):

In dugouts opening into trenches and boyaus.

In dugouts opening behind an elevation of the terrain, a dirt pile, or into a sunken road.

In groups of dugouts forming real barracks in the open field or in woods.

In quarries.

Into tunnels (no new tunnels are being made. See appendix of June 10, 1917, Par. 7).

Into prepared cellars (rarely).

The only indications are:

Dirt heaps, sometimes carried quite a distance by narrow-gauge railway of 60 or 40 cm.

Trampling.

Paths.

Entrances, ventilating shafts, etc.

Use of stereoscope is indispensable.

B. *Rest camps* are located in:

Woods.

Open fields, but protected from ground observation stations or balloons.

Villages.

Indications are:

Presence of barracks.

Paths disappearing in woods.

Horse training tracks.

Proximity of drill-fields, bomb-throwers' works, shooting ranges.

It is above all the prisoners who supplement this information.

Duplicate works (Pl. XXIII, 1).—It is in the vicinity of the rest camps that duplicate works are often found, indications of an offensive in preparation against a part of our trenches. As soon as they appear, the trench tracings must be looked for.

Hospitals, cemeteries (Pl. XXII, 4).—Here should also be mentioned hospitals (with very apparent red crosses) and military cemeteries, where the alignment of the graves is characteristic.

8. COMMUNICATION ROADS.

Study of communication roads is of capital importance for the determination of vulnerable points (road intersections, obligatory passages) and sector limits.

A. *Boyaus* (Pl. XXVIII, 2.—XXXI).—It is necessary to distinguish between the principal boyaus (usually two for each battalion sector), extending toward the rear, and the very numerous auxiliary boyaus connecting the lines of a position, of which some are not used and play the rôle of fake works. The first are wider and deeper and often bordered by a narrow path. Their intersections with the trenches are disposed in a way to avoid destruction. (See Regulations Dec. 15, 1917, Par. 38.)

The tracing of all the communication trenches must be carefully followed (Pl. XIX, 3.—XXX, 3 and 4), in order to find the organized parts (firing step, niche, notch in embankment), the parts enfiladed by a machine-gun in a traverse, or by a machine-gun outside of a boyau in a dominating position.

Covered boyaus are quite numerous. The line is visible and sometimes the air-holes.

B. *Paths.*—In the interlacing of paths which cover the terrain, at a certain distance from the trenches, the questions are:

Which are the most important?

Which are the most frequented?

By whom are they used?

It is generally necessary to have recourse to interrogation of prisoners, contact patrols, observation stations and balloons in order to be completely informed. In any case, the comparison of successive photos, the appearance of the paths themselves and especially snow photos show what paths are used. Their width, the traffic (but it is necessary to bear in mind the circulation discipline required by the German rules and give careful attention to the terrain. If it is marshy, the paths have a tendency to spread out). Lastly, in following their course, one will often discover well camouflaged organizations (headquarters, observation posts, dugouts, etc.). The replenishing trenches of the infantry and artillery may be differentiated and the obligatory passages will be noted. (Pl. XXIII, 1 and 3.)

C. *Roads.*—New roads are to be sought out. Clean ditches and cesspools are indications of good upkeep. Coverings along or across the roads indicate travel. (Pl. XXIII, 1 and 3.)

D. *Railroads* (Pl. XXIV).—(*a*) Normal roads.—New roads are always betrayed by earthworks. The points to look for are, branch roads, double cross-overs, spur tracks and stations. And in a station: turnouts, switches, platforms (length and purpose).

(*b*) *Narrow gauge* (Pl. *XXV*).—Railways of various widths (1 meter, 0.8 m., 0.6 m., 0.4 m.) must be distinguished from highways and from each other.

The 1.8 meter roads may be identified by the earthworks. The 0.6 m. and 0.4 m. roads by their clear-cut lines and regular curves. The 0.6 m. and 0.4 m. systems are frequently changed and remain visible for a long time after the rails have been removed. On large scale photos the rails and ties show.

On the one hand, the transshipping stations (in regard to disposition of roads and platforms) and, on the other hand, the points to be served (various depots and replenishing centers) are to be studied.

Supply depots (for munitions, see part 3) are recognizable by squares or regular rectangles separated by allies and turnouts about which the earth is trampled.

Replenishing centers are distinguished by their location. These are trodden places to which pedestrians and vehicles throng.

In regard to all these details, prisoners will give valuable information.

(*c*) *Cable roads.*—*Transporting cables.*—These are rectilinear and, on account of the leveling are easily identified. The supports are often visible. (Pl. XXV, 6.—XVII, 1.)

9. COMMUNICATIONS AND AGENCIES OF COMMAND.

The various means of communication are enumerated in the third part. We will confine our attention here to those which photography may help to discover.

A. *Telephone lines.*—Telephone lines enable us to discover most of the vulnerable points of the enemy command—observation posts, telephone centrals, headquarters. They are either aerial or in shallow trenches. They are no longer buried on account of difficulty of repairing.

The former are recognizable by the alignment of whitish points, at regular intervals and connected by a narrow path.[1] The latter, by

[1] The enemy knows these means of search. Also the camouflage of aerial lines is prescribed (Orders of German General Staff of June 23, 1917). But the methods recommended (fresh earth at foot of poles, green insulators, etc.) do not seem likely to render them entirely invisible.

a straight boyau (which is now being made wider to facilitate the passage of the repair gangs). (Pl. XXVI—XXVII, 2 and 4.)

One can generally distinguish the lines of the command proper and of the artillery.

B. *Observation stations.*—(For details of construction, see Regulations of December 15, 1915, Par. 70 and 72.) Most of the stations are constructed outside of the trenches—some in the form of concrete shelters, showing a certain relief; others in pits communicating with an underground dugout, whose entrance is in a neighboring boyau, or behind a mound if the level is suitable. The openings of these pits are carefully camouflaged. (Pl. XXVII—LI.)

The directing plan and stereoscopic photos assist in locating observation stations. A telephone line is the surest indication, as it also is for observation posts in houses and ruins.

Oblique photos often enable the discovery of loopholes. (Visual observation stations can often be seen by the Information Section of Field Observers and particularly by special ground observers provided with spyglasses of high magnifying power; also for observation posts in trees. Observation posts in trees are not visible, excepting perhaps in winter. On the contrary, the pylones show in stereoscopic views. (Pl. LI, 5.)

C. *Telephone centrals* (Pl. XXXVI, 2).—These are dugouts situated near the converging points of telephone lines. They are often near observation stations of headquarters and share the importance of the latter. (In the orders of the German General Staff of June 23, 1917—cited on preceding page—the lines must converge at some distance from the centrals. The "Grouping of Sissonne" fixes this distance at about half a kilometer.)

D. *Headquarters* (Pl. XXVIII).—The discovery of battalion, regimental, and artillery headquarters is relatively easy. They are strongly fortified dugouts, near which are the various means of communication. The search can therefore be guided, aside from telephone wires, by the radiogoniometric installations revealing radio stations, by the discovery of visual telegraphy stations, etc.

E. *Visual telegraphy stations* (Pl. XXIX–XI, 1; XXVIII).—These stations are visible on photos. They are generally reinforced shelters (showing hardly any relief) which necessitates, unless it is on a dominating point, cuts in the surrounding ground in order to direct the luminous rays. It is necessary to start from the most characteristic visual stations and, by extending the directions, find the corresponding posts located near headquarters. Where the field requires it, relay stations have been installed. Stations in woods necessitated rectilinear cuts (Pl. XXIX, 2).

F. *Radio.*—Important radio installations are visible on photos.

G. *Messenger relay stations* sometimes appear in the form of light shelters, along boyaus or paths connecting the various headquarters.

CHAPTER II.

STUDY OF THE WHOLE.

The various elements of a defensive organization are connected by logical links which a systematic study can discover. Supplemented by other sources of information, it results in reconstructing the defensive designs of the enemy and renders possible, at the moment of attack, a judicious distribution of the artillery, for destruction and defense.

1. KNOWLEDGE OF THE TERRAIN.

The study of the whole requires a thorough knowledge of the terrain, in order to take account of flanking positions, sunken parts, commanding points, etc. Panoramic, stereoscopic, vertical views taken at a late hour to show shadows, are utilized. (Pl. VII.–X.)

2. SEARCH OF SECTORS.

Independently of Second Bureau reports, the elements to be considered are: boyaus, paths, communications, headquarters. Starting from the rear, a careful study is made of the principal replenishing stations (one for each division) and of the systems of narrow-gauge railways and trails leading toward the front. The two or three long regimental roads, serving the zones of the front-line reserves, will first be distinguished; then the principal boyaus of the battallion sectors. The comparison of this sector study with that of the radio system will give valuable results. These comparative studies are indispensable.

3. STUDY OF DEFENSE PLAN.

The basis of this study is the search for flanking defenses. These are either machine guns, or organized parts of boyaus and trenches, or supporting works.

The supporting works (Pl. XXVIII, 2–XXX), which are carefully noted on the German plans and sketches, are often difficult to discover, for they are often lost in the network of boyaus and trenches. They consist of two or three organized sections, sometimes with barbed wire entanglements. Usually they have no dugout, but in the vicinity, and connected by boyaus, are supporting troops who come to them in case of alarm. These supporting points are either

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in the fighting line between the second and third trenches or succeed each other in the rear, back to the intermediate line, or line of artillery protection. Or, to employ the terms of the German regulations of August 17, 1917, the supporting points are located in the front or fighting zone and also in the zone of principal resistance. A form of defensive organization, where this rule was applied, appeared north of the Somme (Pontruet-Gricourt front). In the first line was a series of small supporting points, surrounded by barbed wire entanglements, at intervals of 100 meters and preceded by rifle pits. Their locations are changed with the plans of defense.

Parallel with the search for these resistance centers, a study must be made of the reserves and the direction of their intervention, of dugouts, obstructions in wire entanglements, outlet stairways. Lastly, must be noted the defenses of shell holes and faked works of less depth where, however, a limited circulation is often possible. It is useful to confirm all these data by questioning prisoners, by documents, etc. (Pl. XXXI–VI.)

There will be studied, in the same manner, the positions, the successive fighting zones, the transverse trenches. There will then be reconstructed the plan of defense in depth, based on the division of the terrain and the successive location of defensive works. Isolated defenses (enclosed works, trench fragments) must always be carefully noted. They will often be ultimately connected. (See German Regulations, pt. 1, sec. A, par. 2.) Certain works will be camouflaged for a long time after their construction. Others, on the contrary, will be discontinued. The variations of the plan of defense can thus be followed, by constant surveillance and continuity of photographic study.

CHAPTER III.

REAR LINES OF DEFENSE.

The rear lines of defense do not require special study. They consist of elements which have already been viewed in detail. (Pl. XXXII and XXXIII.) The only points to examine are:

(*a*) Their *location.*—They are generally located back of some natural obstacle (a wide valley, marshy or easily flooded land) and cover Artillery observation stations. They consist of one or more lines on the opposite (rear) slope and often of a line on the (front) slope toward the enemy (see Regulations of Nov. 13, 1916). The tracing is always adapted to the lay of the land.

(*b*) *Disposition of trenches*, connecting these lines to the old lines.

(*c*) *Order of the works* (see Regulations of Nov. 13, 1916, and of Aug. 15, 1917).—This varies according to locality, communication

facilities, and available materials. The first indications are sometimes dugout excavations, sometimes barbed-wire entanglements. The latter works are seldom preceded by staking out the trenches. Plates XXXII and XXXIII show the various types of rear defense lines. Constant surveillance of these lines during their construction is the only way to *discover the exact location* of the dugouts (which are later lost amid the trenches) and to *know their type* (construction of narrow-gauge railway for carrying the concrete).

PERIOD II.—DURING THE BATTLE.

CHAPTER I.

DURING THE BATTLE.

During the course of the preparation, the question may arise as to whether a certain trench is occupied (Pl. XXXV).

With large-scale photos the men may sometimes be seen, but the true indices of occupation are the trails of replenishment or relief, most visible on photos taken in the morning. They also indicate the location of reserves and sometimes of headquarters.

Photos of the rear enable us to locate camps in open country (previously in woods) or reinforcements, to see new currents of travel, and to judge accordingly of the disturbance caused by our defensive fire.

Destructions will be studied in part three.

CHAPTER II.

END OF BATTLE.

At end of battle (Pls. XXXV, XXXVI, XXXVII, XXXVIII) it is important to determine exact position of lines. This is the object of Bengal lights and location panels, often confirmed by photos. But generally it is not until several hours after the attack, and even the following day, that photos will show the organization of field and location of lines.

1. DISTINGUISHING FRENCH AND GERMAN LINES.

In order to direct this search a knowledge of terrain forms is indispensable. Necessary indications for intelligent study of photos are:

(*a*) Paths ending in shell holes or trench fragments and their direction toward the rear.

(*b*) Barricades in trenches or boyaus, if still existing.

(*c*) Organization of enemy trench elements (notches in parados) or of shell holes.

(*d*) Direction in which earth is thrown out.

(*e*) Direction of boyau beginnings.

When the Germans dig a hasty trench the purpose is generally evident. Traverses are often reserved.

2. SEARCH FOR ORGANIZED PARTS, MACHINE GUNS, AND MORTARS.

Outside of organized holes and trench elements attention must be given to earthworks, ditches, sunken roads, hedges, walls, old battery casemates.

For machine guns the search will be guided by shape of terrain (requiring stereoscopic study) and lookout for flanking positions.

Mortars and grenade throwers are also placed in shell holes. Narrow paths usually end in these (Pls. XXXVI, 3; LVII, 1 and 2).

It is during this end-of-battle period that large-scale photos (thoroughly studied with a magnifying glass) are indispensable.

3. SEARCH FOR RESERVES.

Upon this study (Pl. XXXVI, 2) will perhaps depend the anticipation of counterattacks. It is necessary to look first for any shelters that may be only slightly damaged (old casemates, tunnel exits, etc.), then for any elevations of the ground that could conceal reserves. Paths leading to them should be watched. These are the possible covered approaches.

THIRD PART.—ARTILLERY ORGANIZATIONS.—DESTRUCTIONS.

PERIOD I.—BEFORE THE BATTLE.

Aerial photos make it possible to:

(*a*) Locate with certainty some enemy batteries.

(*b*) Determine exact position of batteries approximately located by other means.

(*c*) Notify other information agencies of suspected points to be watched.

(*d*) Give, in certain cases, suggestions in regard to probable occupation of battery, average firing direction, method of construction, and consequent means for destroying it.

CHAPTER I.

GERMAN BATTERY TYPES.

German batteries may all be included in a small number of types:

Batteries protected by breastworks.

Casemated batteries.

Sunken batteries.

Long-range heavy artillery.

A. *Batteries protected by breastworks.*—This type, very common in 1914–15, has now been almost abandoned. Breastworks still appearing on photos of old sectors are generally unoccupied.

It is, however, to be noted that, when an offensive or defensive operation has led to changing location of Artillery, the type of battery with breastworks may be found as a temporary installation, or in case of permanency, as the first step toward a stronger construction, tending ultimately to approach the other types.

B. *Casemated batteries.*—The Germans install under casemates almost all their long-range batteries and some short ones.

Some casemates (with movable front part, or which have breastworks in front) may alternately shelter short and long guns (Pl. XL, 1). Casemates of trapezoidal or rectangular form are generally in fours, sometimes in sixes or twos, rarely single. They are not always in line. In their immediate vicinity, shelters are constructed for the personnel and munitions, connected to each other by a boyau.

The value of casemates is quite variable, but they are generally carefully built (Pl. XL, 2). The logs used are generally of large diameter, in several layers, and held together by iron bands.

Concrete casemates are sometimes built in one piece and sometimes of blocks weighing about 60 kilograms, made in the rear and assembled on the spot (Pls. XXXIX, 1; XL, 3 and 4).

C. *Sunken batteries* are generally built for short guns firing at high angles (Pl. XXXIX, 2). They are in uncovered pits, connected by boyaus or tunnels to dugouts for men and munitions (Pl. XXXIX, 2).

D. *Underground batteries* (Pls. XXXIX, 3; XLIII, 3 and 4).—The high-angle guns are sometimes installed in deep cavities, without projecting at all above surface of ground. These cavities are, according to circumstances, like mine chambers, or open pits, closed, after firing, by a strong roof.

When the lay of the land permits it, the gun locations are dug in the side of a hill at the base of a slope toward the French front. This arrangement permits the underground installation of long guns (Pl. XXXIX, 4).

E. *Anti-aircraft batteries* (Pl. XLVI, 4).—Anti-aircraft guns are recognizable by the circular shape of the breastworks or excavations protecting them.

Since the beginning of 1917 (Pl. XL, 5) the Germans have used anti-aircraft guns of small caliber (2 cm., 3.3 cm.), to oppose incursions at a low altitude over first-line trenches. Their installation is somewhat similar to that of ordinary anti-aircraft guns.

F. *Fake batteries.*—Germans construct few fake batteries. Those in existence are generally recognizable by the too great clearness of the blast marks and artificial trails (Pl. XL, 6). On the other hand, there are in the German lines many spare emplacements, largely unoccupied, which serve the purpose of fake batteries.

German instructions, coming from a division in the Aisne sector, prescribed the construction of four emplacements for each battery—one advanced emplacement, one advanced spare emplacement, one rear emplacement, and one rear spare emplacement.

CHAPTER II.

BATTERY SEARCH.

1. VERY APPARENT BATTERIES.

When the tactical situation necessitates rapid installation of batteries on field offering no natural cover, the Germans sometimes neglect any attempt at concealment. They then frankly accept the pros-

pect of undergoing our fire of demolition and expend all their efforts in providing effective shelter for men and munitions.

Batteries of this type, usually of the sunken variety, appear on the first examination. Their photographic study has for its object the determination of the following points:

(*a*) Whether battery is occupied—by appearance of field about the guns, by changes in trails, dirt piles, etc., appearing on successive photos, and by the clearness of the blast marks.

(*b*) Mean direction of firing—extension of axis of casemate, excavations, and blast marks. Direction of firing deviates greatly from alignment of battery.

(*c*) Method of construction and probable resistance to destructive fire.

(*d*) Type of guns—projecting casemates, very visible blast marks of long shape, characteristics of long guns.

Do not neglect to examine carefully the field and the covers in the neighborhood of very apparent positions (Pl. XLI, 3 and 4). It often happens in fact that, to escape the action of our artillery, very visible batteries withdraw a short distance to concealed positions, while keeping up the appearance of activity about their old positions. In snowy weather all active batteries can be considered as very apparent (Pl. XLI, 5). German instructions (General Instructions on Organizing Positions) prescribe surrounding of batteries with barbed-wire entanglements. This feature facilitates its discovery in snowy weather. This is of great interest to the infantry in case of an advance and should be carefully noted (Pl. XLI, 5).

2. CONCEALED BATTERIES.

Very apparent batteries are the exception. Concealed batteries are the rule. Germans conceal their batteries by—

Camouflaging.

Disguising (infantry works).

Utilizing accidents of the terrain (dirt piles, quarries, and especially sunken roads).

Utilizing covers (hedges, orchards, demolished villages, woods).

Method of search.—Some concealed batteries appear on photos (blast marks, traces of travel, dirt piles, etc.), but for finding many of them photography alone is powerless. A close and constant collaboration of all means of information is alone productive of results.

Every battery position located by the Information Section of Field Observation, Section of Locating by Sound, Balloon, Airplane, Interrogation of Prisoners, must be made the subject of careful study

on the corresponding photos. This study takes into account all the elements of estimation (number of observations, intersections, dimensions of caps, etc.), and enables either to distinguish, on photos, points previously overlooked, or to give a definite interpretation to points not clearly enough shown on the photo.

On the other hand, all suspicious points revealed by photos (white streaks in woods, trails of unusual form, peculiarities of trails, ending points of railways or telephone conduits, etc.) will be carefully noted and transmitted to the other organs of investigation. By submission to constant surveillance these points may be ultimately identified by:

Observers (airplane, balloon, field, etc.) who have photos of the terrain.

Interrogation of prisoners.

Examination of successive photos of same point.

Examination of snow photos.

Examination of photos taken after the first firing at a given target.

Some of the following examples will illustrate the importance of this double comparison. (In order to become familiar with the characteristics which render possible the recognition of the batteries, it is indispensable that the officers in charge of the exploitation should accustom themselves to finding French batteries on photos of the French front. It is also important for them to inspect these batteries from time to time, with the photo under their eyes. This practice is not only very useful for their own education, but also renders great service to the battery officers, who are thus enabled to correct the faults of their installations.)

A. *Camouflaged batteries in open field* (Pl. XLII).—However well camouflaged, casemated or sunken batteries, whose projections show shadows, may always be readily distinguished on photos.

Underground batteries are less apparent and their camouflage is sometimes perfect (Pl. XLIII, 3 and 4), but in any case an attentive observer, with a thorough knowledge of his terrain, should not let a camouflaged battery in open field escape, especially if he has photos taken at near enough intervals to discover works in process of construction.

In certain regions (Pl. XLIII, 1) batteries are sometimes covered by an artificial mask, which seems designed rather to interfere with our spottings and to prevent our observers from noticing signs of activity than for concealment.

B. *Batteries in sunken roads.*—Sunken roads are remarkably adapted to the installation and concealment of batteries. The excavations for the guns, cut in the embankment toward the French front, are very difficult to discover, if they are covered with a roof

which reestablishes the continuity of the ridge of the embankment (Pl. XLIV, 1). The dugout entrances are not apparent and the excavated material is readily transported to the rear. Travel in the sunken road, which fills the office of supply boyau, leaves no trace. The blast marks are sometimes apparent (Pl. XLIV, 3–XLVIII, 1), because the gun muzzles are very near the outside ground. It is, therefore, this characteristic, confirmed in some cases by a slight sinuosity or different color of the embankment, that must be sought on the border of the sunken roads, which by their direction and distance from the front seem adapted for the installation of a battery.

C. *Batteries in infantry works* (Pl. XVIV, 4 and 5).—In open terrain it is easier to disguise a work than to conceal it. This is why the Germans often give their batteries the appearance of second-line infantry works, either isolated or blended with the whole line. Batteries of this kind are difficult to discover. Their earthworks and shelters are mingled with those already known and supposed to be unoccupied. The travel through the boyaus and trenches leaves no trace. Quite often, however, a variation in the direction of a trench, or an increase in the width of the embankment, betrays a battery emplacement.

D. *Batteries in villages* Pl. XLV, 1, 2).—Guns installed in cellars or even in courts of partially destroyed houses are blended with the débris of the demolished buildings and are almost impossible to distinguish. Some indication may, however, be given by the more marked traces of travel about certain houses.

E. *Batteries in hedges, orchards, etc.* (Pl. XLV, 3, 4, 5).—An orchard, even scattering, a hedge, though narrow, may completely conceal a battery, if the occupants take sufficient precautions to avoid making paths.

F. *Batteries in woods* (Pl. XLVI, 1, 4).—Woods confer upon batteries an almost complete invisibility. Camouflage by trellis or netting is, moreover, easy and efficaceous. The use of the stereoscope, which is absolutely necessary for the study of woods, enables the location, in quite rare cases, of poorly camouflaged works or of too large quantities of excavated dirt. But more often, photography alone is powerless. It is, therefore, more especially for the spotting of batteries in woods that it is necessary to call upon the other sources of information to search out and watch the suspected points. The following are the most frequent characteristics of these suspected points:

(*a*) *Light patches in woods* (Pl. XLVII, 1).—The travel about the guns and the shelters uncovers the earth between the trees and shows on photos indefinite light-colored spots, quite apparent, if the woods are not too dense.

(*b*) *Inequalities and changes in nature of paths* (Pl. XLVI, 2).—When a path ends abruptly or, from being very wide, becomes narrow, it is because, in the vicinity of the point where the change occurs, there is some work whose presence requires much travel. If, moreover, the character of the terrain and the distance from the front are favorable for the installation of artillery, it is reasonable to infer the possible presence of a battery.

(*c*) *Loop paths* (Pl. XLVI, 3—XLVII, 3).—Same conclusions for paths which turn back on themselves, or describe a closed circuit.

(*d*) *Railway and telephone terminals* (Pl. XLVII, 1, 2).—When a railway or telephone conduit ends at a point suitable for the installation of a battery, the vicinity should be particularly watched.

(*e*) *Rear edge of existing clearings* (Pl. XLVII, 4).—Short-gun batteries are easily installed in the midst of woods. It is not the same for long-gun batteries, which, in order to clear their firing-field, are obliged to fell trees (showing on photos) or to locate on an edge toward the enemy, which exposes them to being quickly spotted by their flashes. It is, therefore, quite natural that the long-gun batteries should seek to utilize the rear edge of preexisting clearings, which become, for this reason, points to be watched.

(*f*) All inequalities, dark or light spots, trails, etc., which occur in fours.

3. POSITIONS OF HIGH-POWERED HEAVY ARTILLERY.

High-powered guns of 15 centimeters (4 or 5 types), 17 centimeter shell guns, 30.5 centimeter mortars and one 42 centimeter mortar of short range (about 9,000 meters) can be transported over roads by tractors, but, in a stabilized position, the necessities of munition replenishment almost always cause the building of a railway ending near the gun (Pl. XLVIII, 1).

Long guns of 21 and 24 centimeters, 42 centimeter mortars of long range (16,000 meters) can fire from trucks or from a platform, but, in either case, a railway brings the gun to the firing place. Guns of 28, 30.5, 35.5, and 38 centimeters fire from a platform at the end of a railway.

Constant surveillance, therefore, of the enemy railway system will make it possible in most cases to locate the firing positions of the high-powered heavy artillery, often before they are used, since the work of installation requires much time. The railway for the Hampont gun was laid in August, 1915, and the first shot was fired January 3, 1916.

Their search, moreover, is simplified by the fact that the conditions of admissible ramps, of minimum radius of curvature, the necessity of disguising the works, tactical obligations, are obstacles

which greatly diminish the possible number of emplacements. It is indispensable, however, to search carefully the territory in the vicinity of apparent emplacements, for Germans often construct false positions, at a short distance from the real ones.

The appearance of the firing positions of the high-powered heavy artillery can help to a certain extent in determining the calibers (Pl. XXXIX, 5). The track for the 42-centimeter truck-gun is in a blind alley, the carriage itself being a revolving platform (Pl. XLVIII, 2). The curved tracks with one or two branches are generally for 24-centimeter truck-guns (Pl. XLVIII, 3). Platform guns of 21 and 24 centimeters are located at the bottom of a pit of about 12 x 16 meters by 1.25 meters deep, bordered by two blocks of parallel tracks, at a distance of 14 meters, for the use of the rolling platform. The road which brings the supplies may have any direction whatever in relation to the firing direction (Pl. XLVIII, 4.—XLIV, 1, 2). The 35.5-centimeter gun utilizes a similar device, excepting that the pit is of larger dimensions (15 x 17 x 3 meters).

The platforms of the 38-centimeter guns are still much larger, in the form of a circle of 20 to 25 meters diameter. The gun is put in place by means of a 14-meter rolling platform whose roller-ways traverse the pit on double T rails. It is possible for the firing emplacements of the 38-centimeter guns, which are not used at their maximum range, to be of simpler construction (Pl. XLIX, 3). The 28 and 30.5-centimeter guns, almost exclusively used on the ocean front, are mounted on large concrete bases (Pl. L).

CHAPTER III.

ARTILLERY LIAISON AND COMMAND.

1. OBSERVATION STATIONS.

There are observation stations of artillery and of the command. All reports from the various sections are sent directly to a central office, which transmits them immediately to those interested. Observation posts can exist only in the vicinity of ridges and culminating points. The zones in which to look for them, relatively restricted by this fact, may be easily found by the aid of a directing map in relief and a small electric light which, held close to the map, shows instantly, for each point, the visible and invisible parts.

Before an offensive operation, designed to penetrate deeply into the German lines, the observation stations are sought out on the heights which command " not only the front lines but also the intermediate and rear." (German Regulations for Conduct of Defensive Fighting in Stationary Warfare.)

The available locations being thus determined, it will be possible to identify on the photos a certain number of observation stations which, in the regions covered by our artillery, are shown as shelters, with or without apparent embrazures, at which telephone lines and a boyau often terminate (Pl. LI, 1).

Where the nature of the terrain permits it, certain artillery observation stations are placed in front of and near the batteries they serve. Near summits with very extensive views, there are groups of observation posts, some serving the artillery and some the command. (Pl. LI, 2). In regions feebly covered by our artillery, the observer often stations himself behind an artificial mask or a hedge near a dugout (Pl. LI, 4). Lastly, very distant stations usually consist of wooden or iron towers, twenty to thirty meters high (Pl. LI, 5).

Many stations, particularly in trees, can not be exactly located. Photo study will, nevertheless, be useful for the approximate determination, in fault of exact location, of a certain number of emplacements which can, at the proper time, be blinded by special shells or smoke bombs.

2. LIAISON AND ORGANIZATION OF ARTILLERY COMMAND.

(In accordance with Regulations of July 15, 1917: "The Service of Liaisons.")

Each German division sector has, in addition to telephone lines, a great abundance of means for maintaining communications between the artillery command and the batteries on the one hand, between the artillery and infantry on the other hand (LII). The following are the most frequently employed:

- Posts for signaling barrages, by rockets, with intermediate posts, in case of fog.
- Messenger posts.
- Radio stations.
- Guiding battery.

Sometimes also:

- Hand-siren posts.
- Oxygen-siren posts.
- Posts for sending messages by projectiles.
- Chains of machine guns.

It is impossible to reconstruct by the study of photos alone the whole organization of the liaisons of a sector. The visual telegraphy stations and a certain number of observation stations can be found. For the rest, it is necessary to carefully note all the visible shelters and dugouts in the immediate rear, even isolated and small, provided they appear frequented. Each of them may conceal one of the agencies enumerated above and their systematic destruction in the

last hours of preparation for an attack will always cause a more or less complete disorganization of the enemy liaisons.

3. BATTERY GROUPS.

Aside from the large caliber long-range batteries (which will probably remain at the disposition of the army), all batteries in position, those of reinforcement as well as the normal allotment of the divisions, are, during a defensive battle, under the orders of the artillery commander of the division. (Principles for conduct of defensive fighting.)

All the batteries of a division sector are divided into regimental groups, designated sometimes by the names of "*Close fighting group*" (field artillery and sometimes heavy short-gun batteries, under the orders of commander of regiment belonging to the Division) and of "*Distant fighting group*" (heavy artillery and especially long-range guns, under orders of a Fuss. Art. Regt. Stab.)

The groups are themselves divided into subgroups, corresponding to the artillery battallions on foot and to the field artillery groups. In regard to type of guns, the subgroups, as well as the groups, are either homogeneous or mixed, according to nature of terrain. Batteries of the same group are not necessarily placed side by side, but are often mingled with batteries of neighboring groups. It is therefore difficult to separate them with certainty by the study of photos alone.

In long stabilized sectors, comparatively free from trees, the making, for each battery, of roads and telephone conduits, connecting it to the other batteries, supply centers, headquarters and observation stations, will sometimes render possible the determination of the batteries belonging to the same group, as also their respective observation posts and headquarters. In this connection, search for firing direction and types of guns (long or short) can also give useful indications.

CHAPTER IV.

MUNITION DEPOTS.

The location of a munition depot is first of all a question of roads of communication (Pl. LIII). Points of convergence of highways, paths and narrow or regular gauge railways and, more particularly, the points where these various means of communication parallel each other, must therefore be carefully examined (Pl. LIV, 1). In this connection, the statements of enemy prisoners, of escaped prisoners

and deserters, are susceptible of helpfully directing photo reconnaissances to the important points.

A. *Depots very far from the front.*—In regions considered beyond the reach of our guns, the Germans do not seem to take many precautions to conceal and protect their munition depots (at least those installed before the recent development of bombarding from airplanes). In this case, the projectiles are piled in regular tiers, probably covered by awnings, and aligned on platforms served by railroads and highways (Pl. XXIII, 1.—LIV, 2, 3). Some less important depots are in isolated buildings (farms or factories), at which terminate numerous trails.

B. *Depots at a medium distance from the front.*—Munition depots, which may be exposed to a bombardment, are not always better disguised, but they are always better protected. Stores of less importance and reserves of explosives are kept in dugouts (Pl. LIV, 4). In important depots, the projectiles are piled in compartments separated by thick earth walls which limit the effects of a partial explosion. The charges are covered in small protected dugouts (Pl. LV, 1, 2).

C. *Depots very near the front.* (Pl. LV, 3).—The munition reserves of nests of batteries, of small capacity and well protected, are difficult to discover. They must be sought along narrow-gauge railways serving the batteries and especially in the vicinity of contact of these railways with the main communicating railroads, if this point is not too distant from the batteries.

D. *Transshipping points during important operations* (Pl. LV, 4, 5).—When an important operation causes a considerable change of the front, the existing depots can no longer perform their usual rôle. It is then, moreover, of great advantage to the enemy, in order to avoid useless handling to ship the munitions coming from the interior directly to the front. He is thus led to create transshipping points, where a large number of extended or newly created roads converge. These transshipment points, which constitute very vulnerable targets, must be sought with care.

PERIOD II.—DURING THE BATTLE.

CHAPTER I.

SEARCH FOR BATTERIES.

When an important operation causes a displacement of the front such that the prepared emplacements can no longer fulfill their tactical task or when, in the course of a battle, the prepared emplace-

ments come under violent bombardment, the Germans often remove their batteries and scatter the guns, uncovered, over a large front. Isolated guns in open field can be spotted immediately after being put in place only by observers having a direct view of the field. However, if the situation becomes stabilized, even after several days, there will be seen, on the photos, improvised dugouts, crude earthworks, or trails made by the inevitable supply vehicles.

CHAPTER II.

STUDY OF DESTRUCTIONS.

1. DESTRUCTION OF ENEMY DEFENSES.

The photo control of destructions, necessarily preceding every offensive operation, must continue without interruption during the first hours of the artillery preparation up to the launching of the infantry attack. Photos brought in by airplanes will be immediately developed and studied, on the negatives themselves, if necessary.

During the preparation, the results of this study will be put in such form that the artillery command will be able to rectify imperfect adjustments and change the distribution of the different calibers, if the displacement of earth produced by the explosions bring to light unsuspected resisting elements (reinforced dugouts, for example). (Pl. LVI, 1.)

During the last hours of the preparation, one single thing is important: to furnish the command with accurate information, in order to enable him to launch the infantry attack at the right moment. Consequently the sole object of the photo study will be to make a complete and accurate map of the trenches demolished, half demolished, and intact.

One may consider as completely demolished, any trench whose outline becomes indefinite in the midst of shell holes almost continuous; as half-demolished, any trench whose outline is easily discernible among numerous disconnected shell holes. (Pl. LVI, 2.—LVII, 1, 2). A completely destroyed village presents the appearance of a light patch, in which no house wall remains apparent. (Pl. LVII, 3). Lastly, a barbed wire entanglement is no longer an obstruction to infantry advance, if it is included in a zone of almost continuous shell holes, even if they are of small diameter.

In case of an enemy offense, the photo study of the destruction of our own trenches will show the probable attacking front and to a certain extent the probable ultimate objectives.

2. DESTRUCTION OF BATTERIES.

Batteries whose destruction have been determined upon must be studied before, during, and after bombarding.

Before bombarding, the exact front occupied by the battery will be determined (not always very apparent in forest batteries), as also the relative position occupied by the auxiliary works, dugouts, commander's headquarters, etc. (Pl. LVIII, 1, 2). The results of this study may help to determine which firing battery can be used to the best advantage. The mode of construction will then be determined (buried, casemated, underground) and its probable resistance (volume of excavated earth, log casemates, concrete casemates), as a basis for determining the caliber necessary to accomplish the destruction. It should be noted in this connection that a projecting casemate may, for lack of large calibers, be put out of business by an embrazure hit of small caliber. It is therefore important to find out, by means of a stereoscope or by oblique photos, whether the embrazures extend above the ground in a nearly vertical plane (Pl. LVIII, 3).

During the bombardment photos make it possible, on the one hand, to control the perfection of the battery adjustment; on the other hand, to correct, if necessary, the conclusions of the first study, since it is much easier to discern the details of construction after the first shots have broken down the camouflages, scattered the earth covering, cut down the trees (Pls. XLV, 3, 4; XLIX, 2).

After bombarding it is possible, from the appearance of the ground, to report approximately the damage done the enemy and to judge whether the battery has suffered only temporary damage or has been completely destroyed (Pl. LIX). It is important to distinguish, in case of incomplete destruction, whether it was due to insufficient caliber or imperfect adjustment (Pls. LIX, 4, 5; LIX, 2, 3).

FOURTH PART.—AERONAUTICS.

Photos enable the discovery and definition of aviation fields, rarely of balloon emplacements. Large hangars have mostly disappeared. Small tents of polygonal form are characteristic. The landing T is now rarely seen and does not necessarily indicate that a given field is being used. It is necessary to have recourse to other sources of information.

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JANUARY 15, 1918

GENERAL HEADQUARTERS OF THE ARMIES
OF THE NORTH AND NORTHEAST

STAFF

STUDY AND EXPLOITATION OF AERIAL PHOTOGRAPHS

II PLATES

LIST OF PLATES.

CONVENTIONAL SIGNS.

Trench.

Boyau (communication trench).

Covered boyau.

Boyau abandonned or traced.

Barbed wire.

Path or trail.

Path leading to listening or observation post.

Railway (standard gauge).

Railway (narrow-gauge).

River or brook.

Observation post.

Location of machine gun.

Trench mortars.

Concrete shelter or blockhouse.

Underground dugout.

Occupied shell holes.

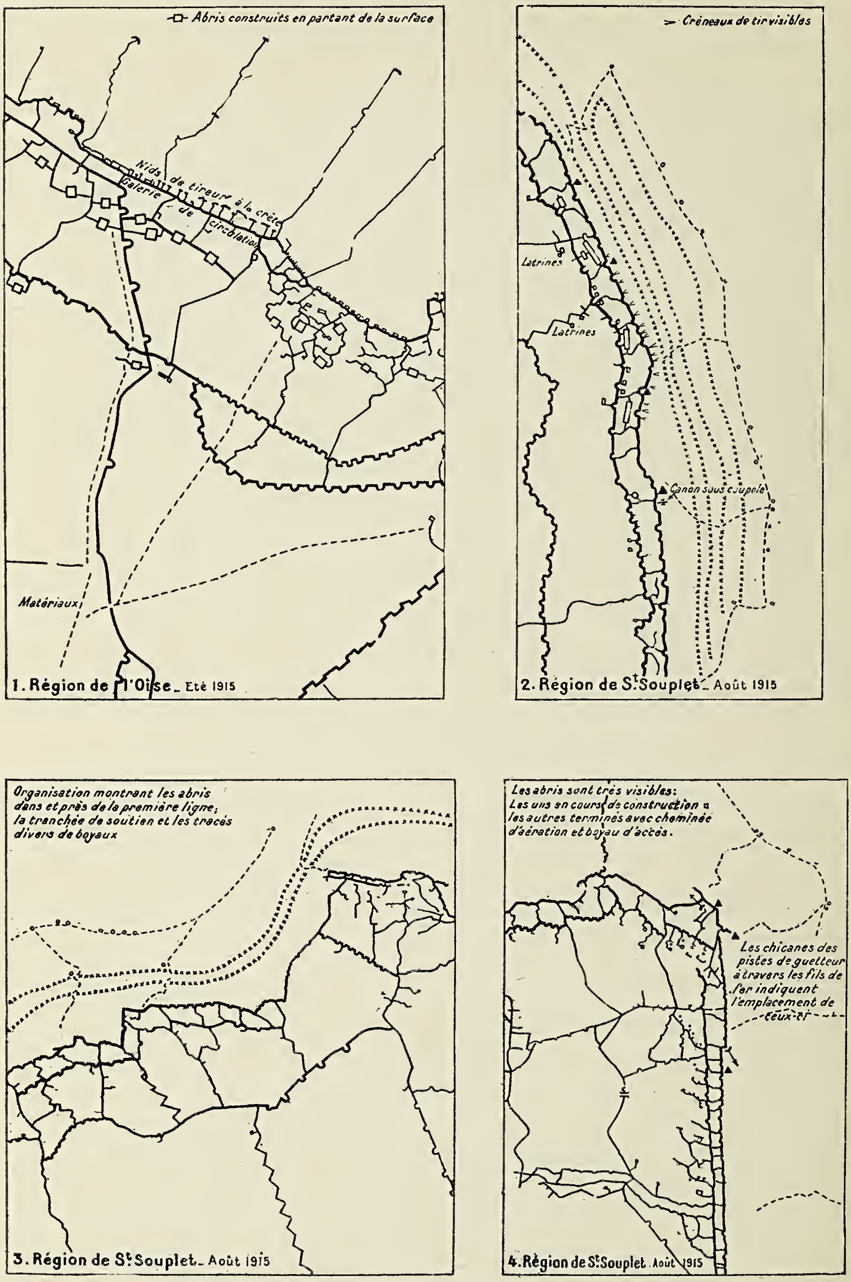
Aerial telephone line.

Buried telephone line.

Visual signalling post.

Barracks.

PLATE I.—German front lines (end of 1914, to Oct., 1915).



1. Dugouts, starting from surface.
2. Battlements visible.
3. Organization showing dugouts in and near front line, supporting trench and various tracings of boyaus.
4. Dugouts are very visible, some in course of construction, others completed, with airshaft and boyau of approach.—Avenues of sentinels' paths through wire entanglements indicate their location.

PLATE I.

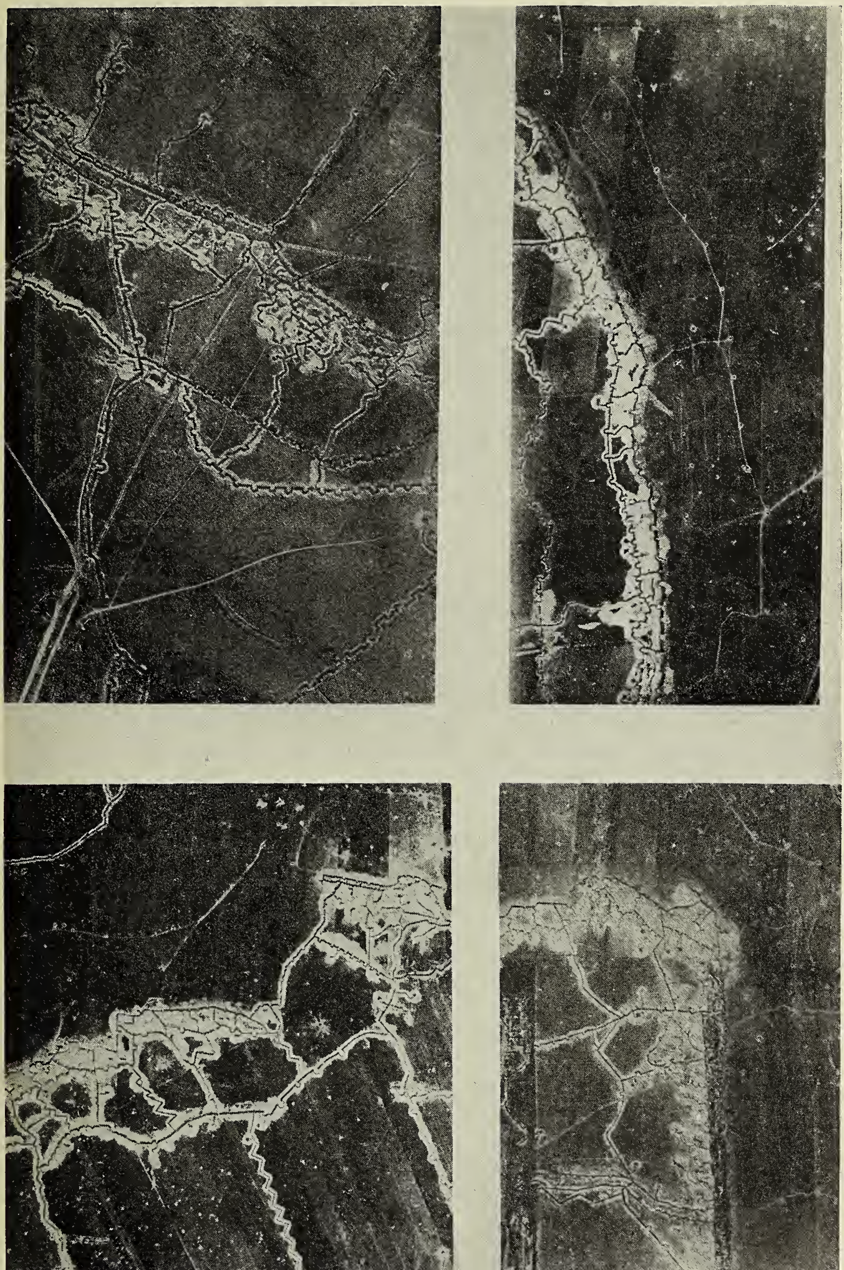
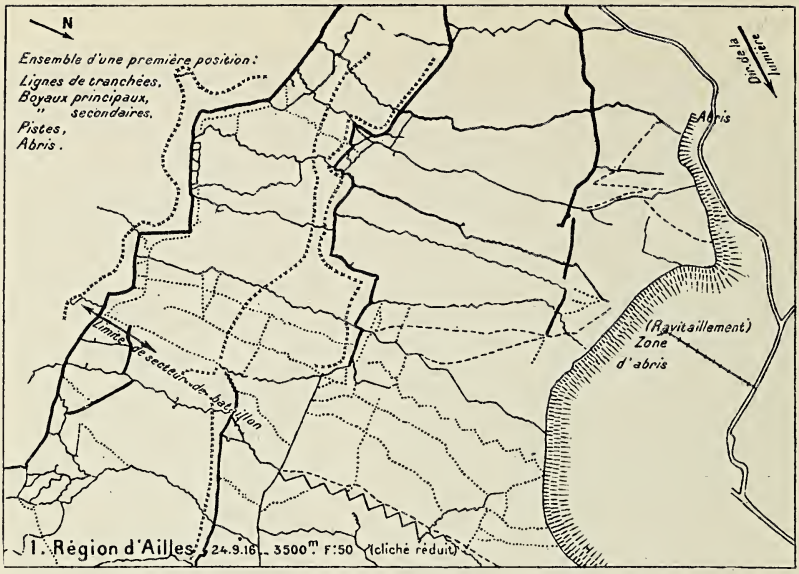
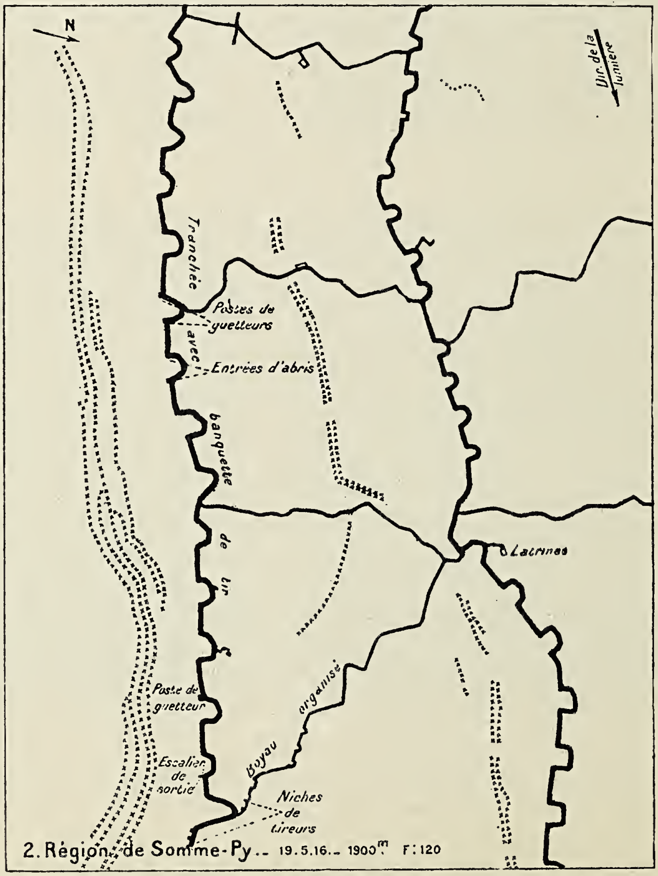
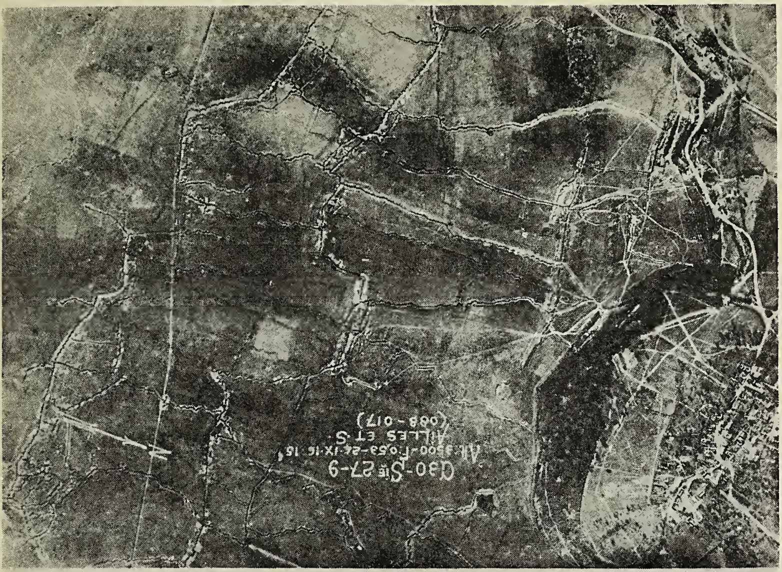


PLATE II.—German front lines (Oct., 1915, to Oct., 1916)





1. Direction of light.—Whole of front lines: Trenches; Principal boyaus; Secondary boyaus; Paths; Shelters.—Limit of battalion sector.—(Replenishment).—Zone of shelters.
2. Trench with firing step.—Sentinel posts.—Dugout entrances.—Sentinel post.—Exit stairway.—Sharpshooters' niches.—Organized boyau.—Latrines.



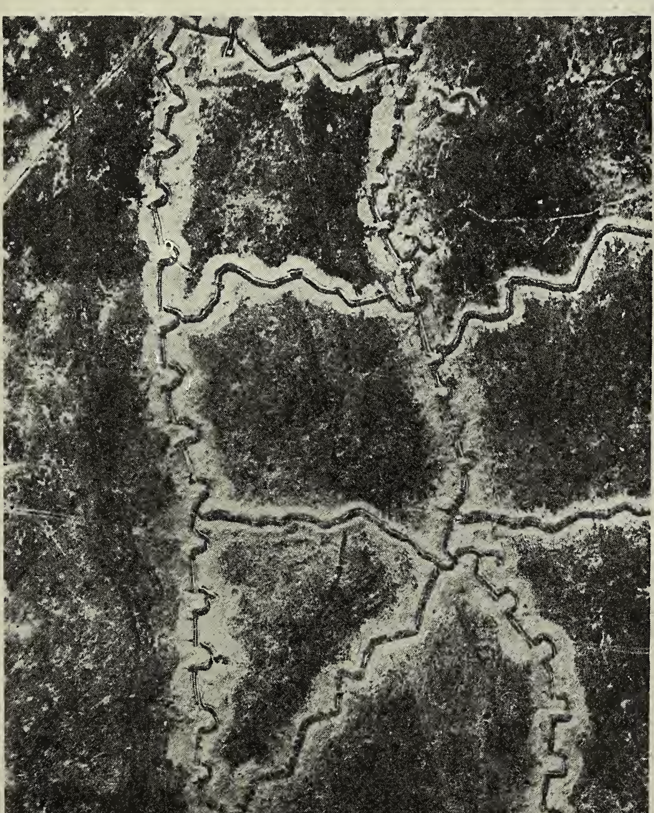
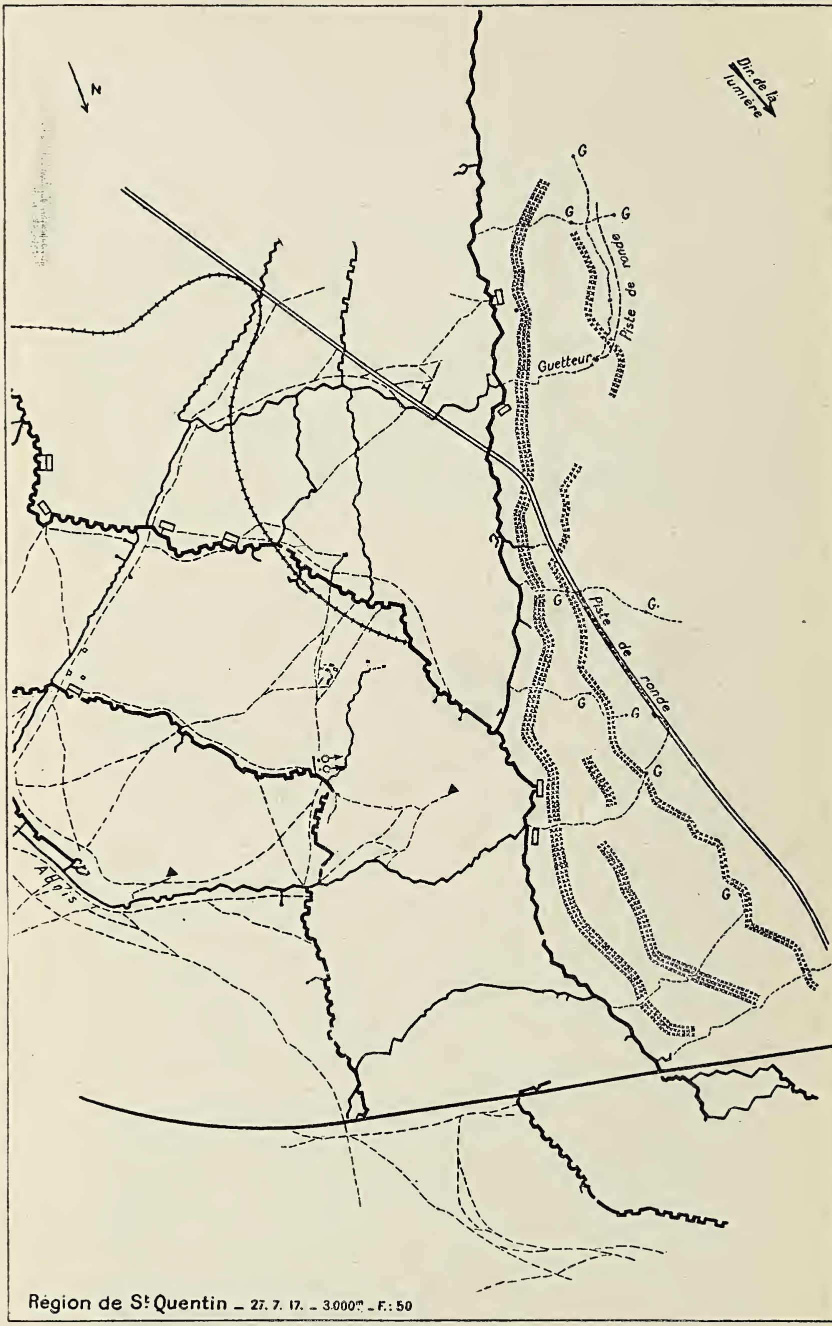


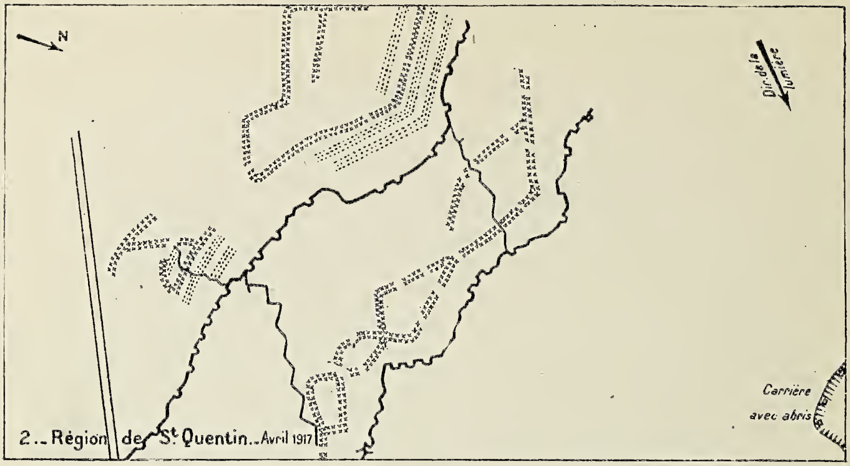
PLATE III.—German front lines (Oct., 1916, to June, 1917)

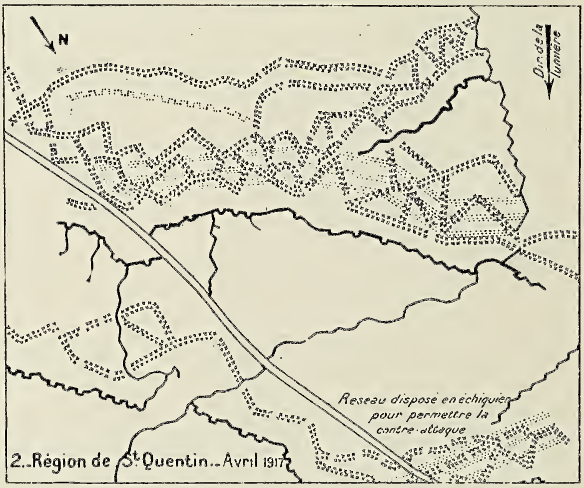


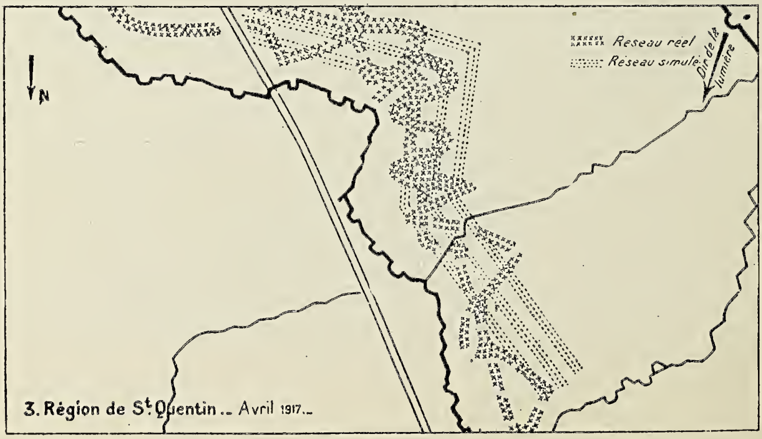
Sentinel.—Trail of rounds.

PLATE III.

PLATE IV.—Wire entanglement (Siegfried trench).







1. Direction of light.—Quarry with shelters.
2. Wire entanglements in checkerboard, to permit counter attack.
3. Genuine entanglement.—Fake entanglement.

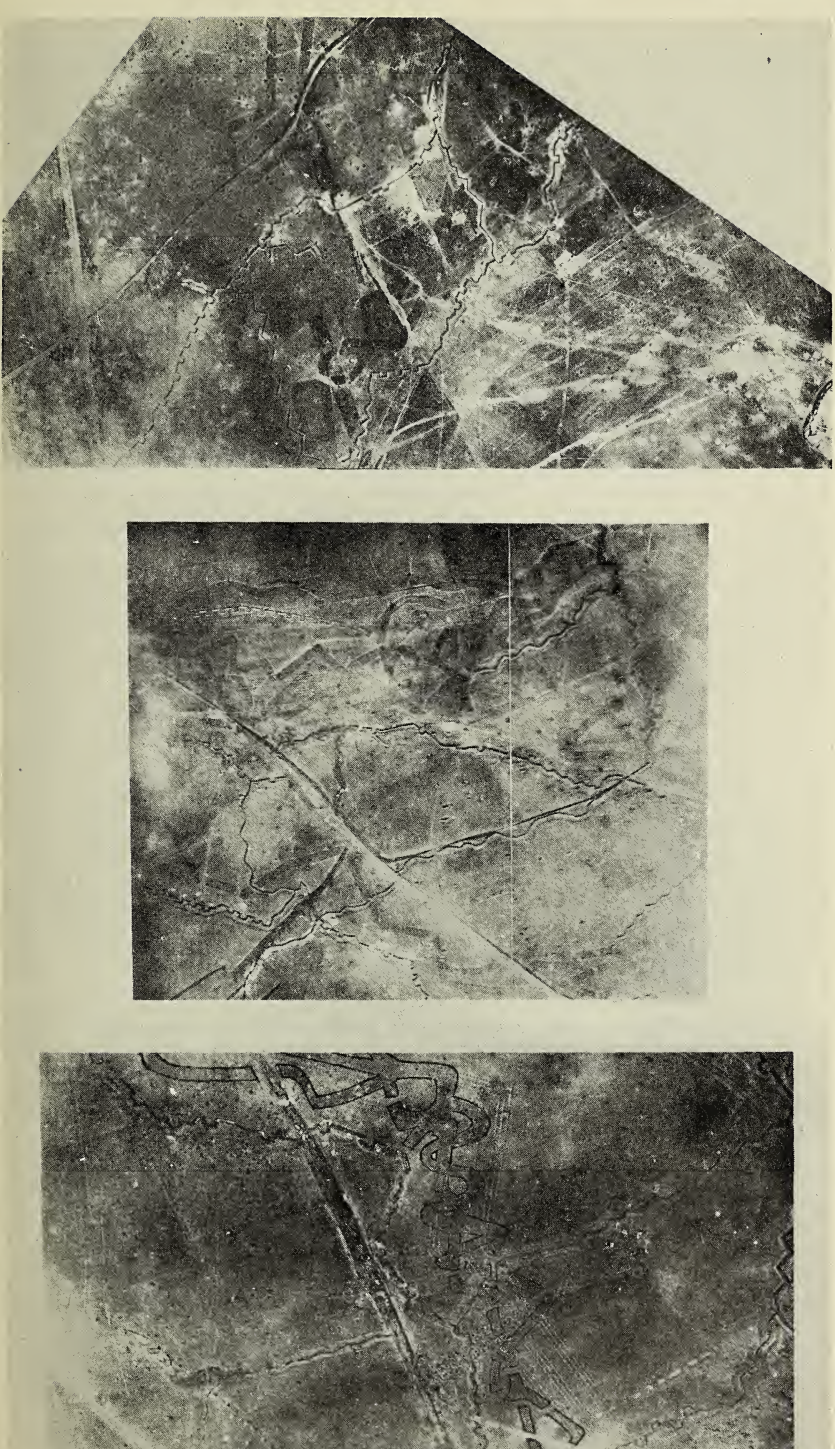
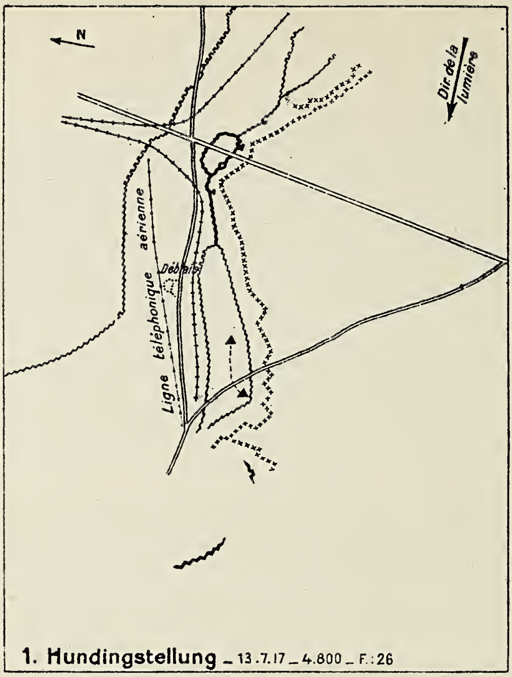
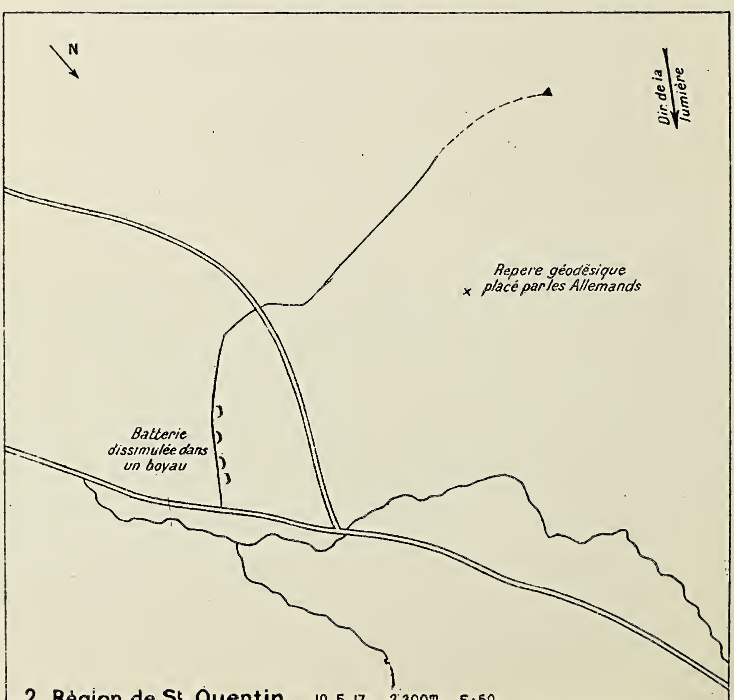


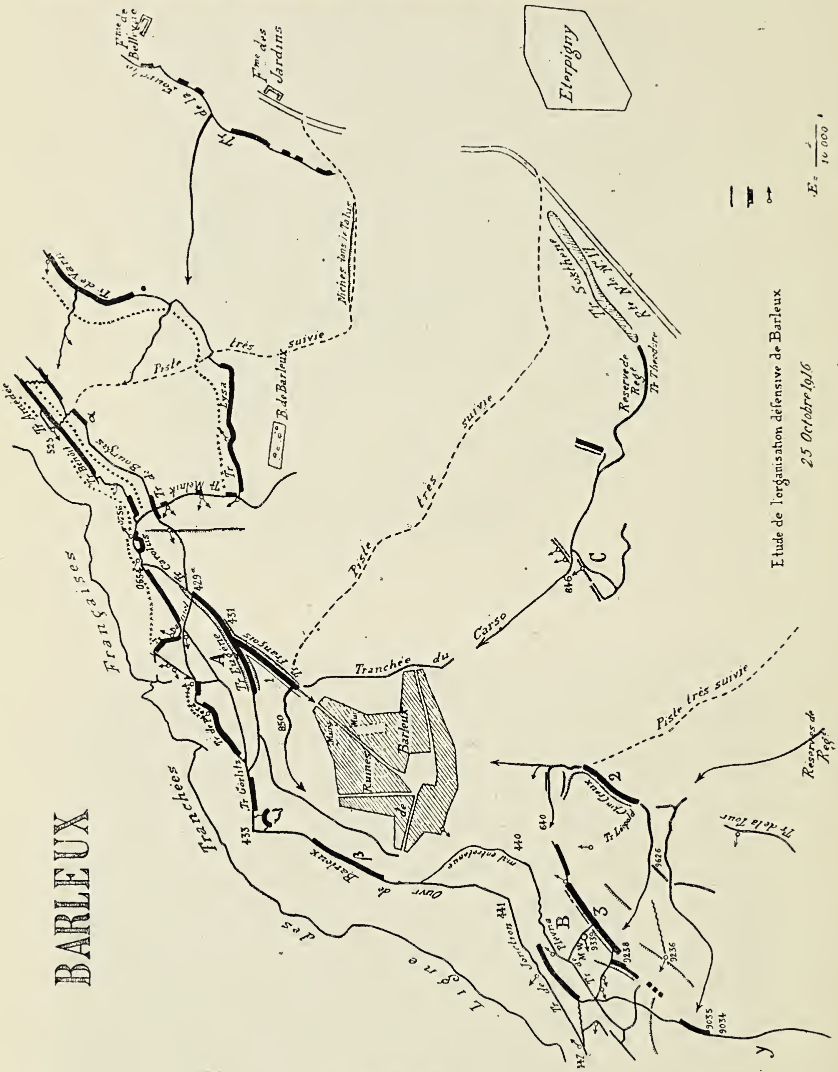
PLATE V.—Line of support (Hunding line). Fake battery.





1. Hunding position.—Aerial telephone line.—Excavated earth.
2. Battery concealed in boyau.—Geodetic landmark placed by Germans.

PLATE VI.—Sketches accompanying interpretation of aerial photos.



BARLEUX.

Study of defensive organization of Barleux. Oct. 25, 1916.
French line of trenches.—Much used trail.—Niches in dirt bank.

LEGEND.

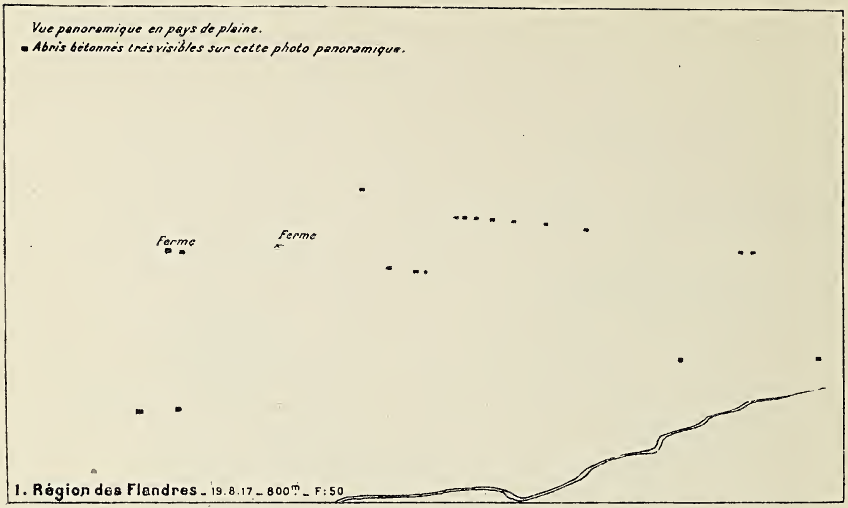
— Trench.
⊡ Trench with dugouts.
o→ Probable machine gun emplacements.

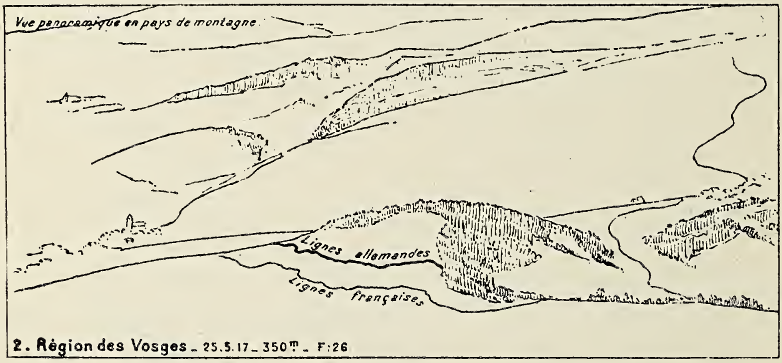
PLATE VI.

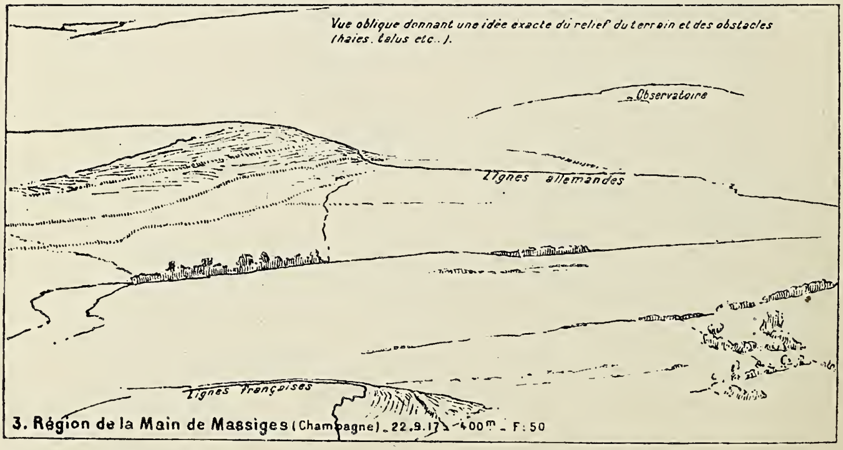
SCALE: About $\frac{1}{40000}$

Study of the defensive organization of Barleux Oct. 25, 1916.

PLATE VII.—Panoramic and oblique views.







1. Panorama in flat country. Concrete shelters very visible on this photo.
2. Panorama of mountainous country.—German lines.—French lines.
3. Oblique view, showing relief of territory and obstacles (hedges, banks, etc.).—Observation post.—German lines.

PLATE VII.

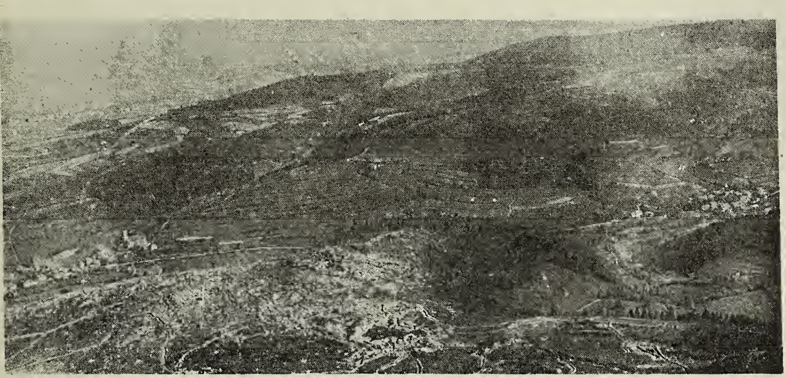
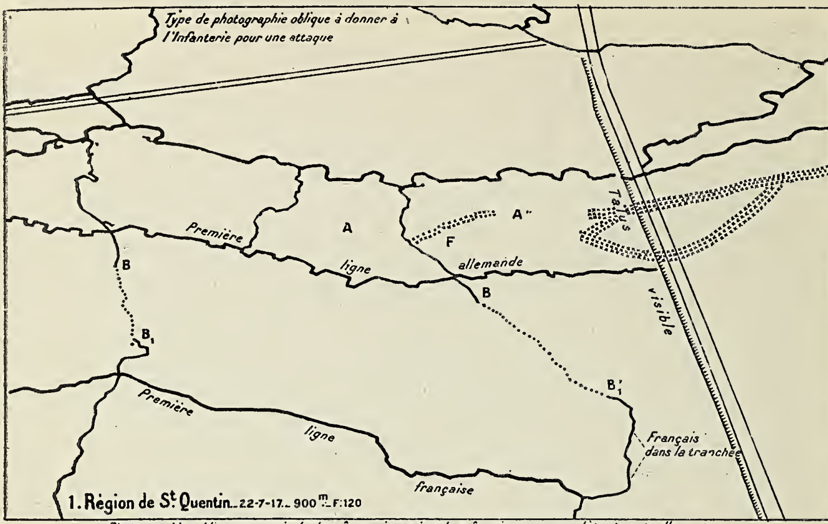
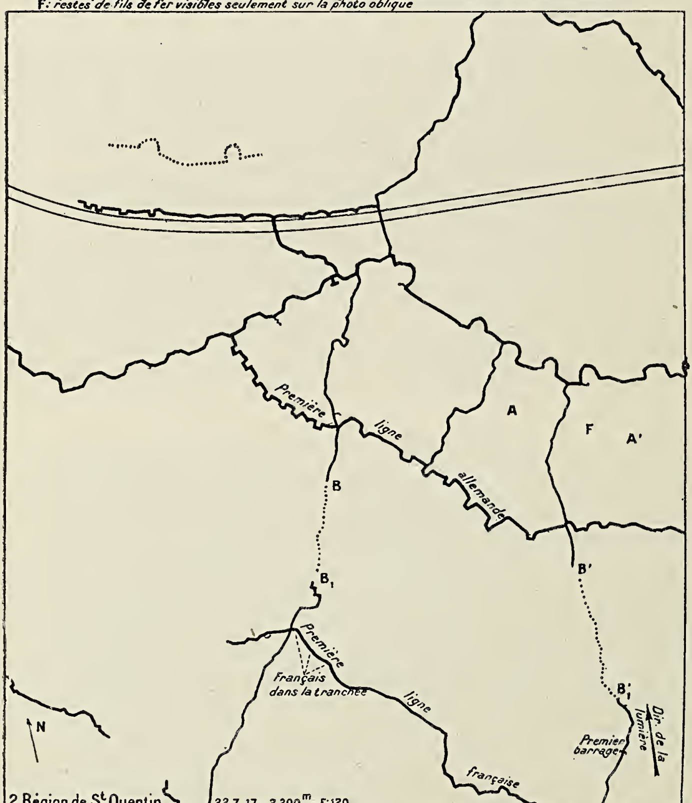


PLATE VIII.—Oblique and vertical views of same section.



Photographies oblique et verticale du même point, prises le même jour, se complètant mutuellement.
A.A': régions de trous d'obus dont la profondeur est plus facilement appréciable sur la photo oblique
$B.B_1.B'.B'_1$: barrages des boyaux entre les deux lignes visibles seulement sur la photo verticale
F: restes de fils de fer visibles seulement sur la photo oblique



Oblique and vertical photos of the same location, taken on the same day, mutually supplement each other.

$A.A^1$. Regions of shell holes, whose depth is more easily estimated on oblique photo.
$B.B_1.B^1.B^1$. Barricades of boyaus between the two lines visible only on vertical photo.
F. Remains of wire entanglements, visible only on oblique photo.

1. Type of oblique photo to give infantry for attack.—German front line.—French front line.—Visible earth bank.—Frenchmen in trench.
2. German front line.—French front line.—Frenchmen in trench.—First barricade.

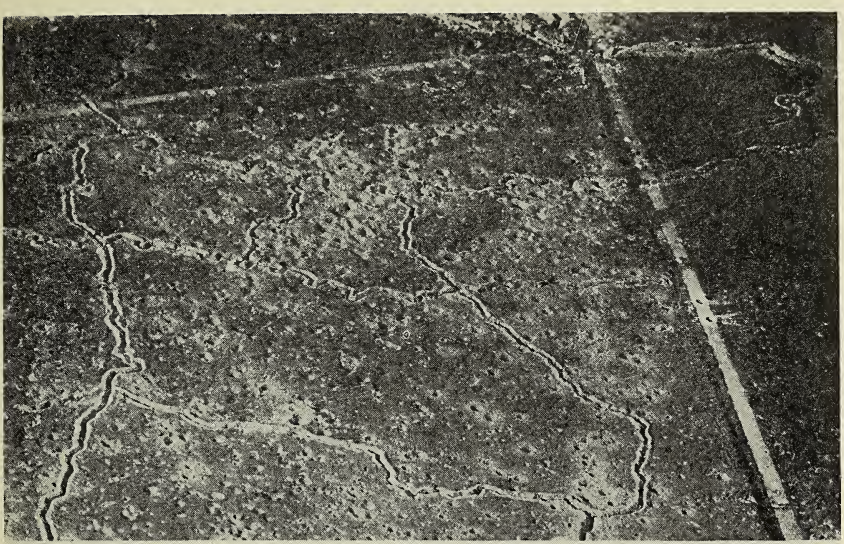
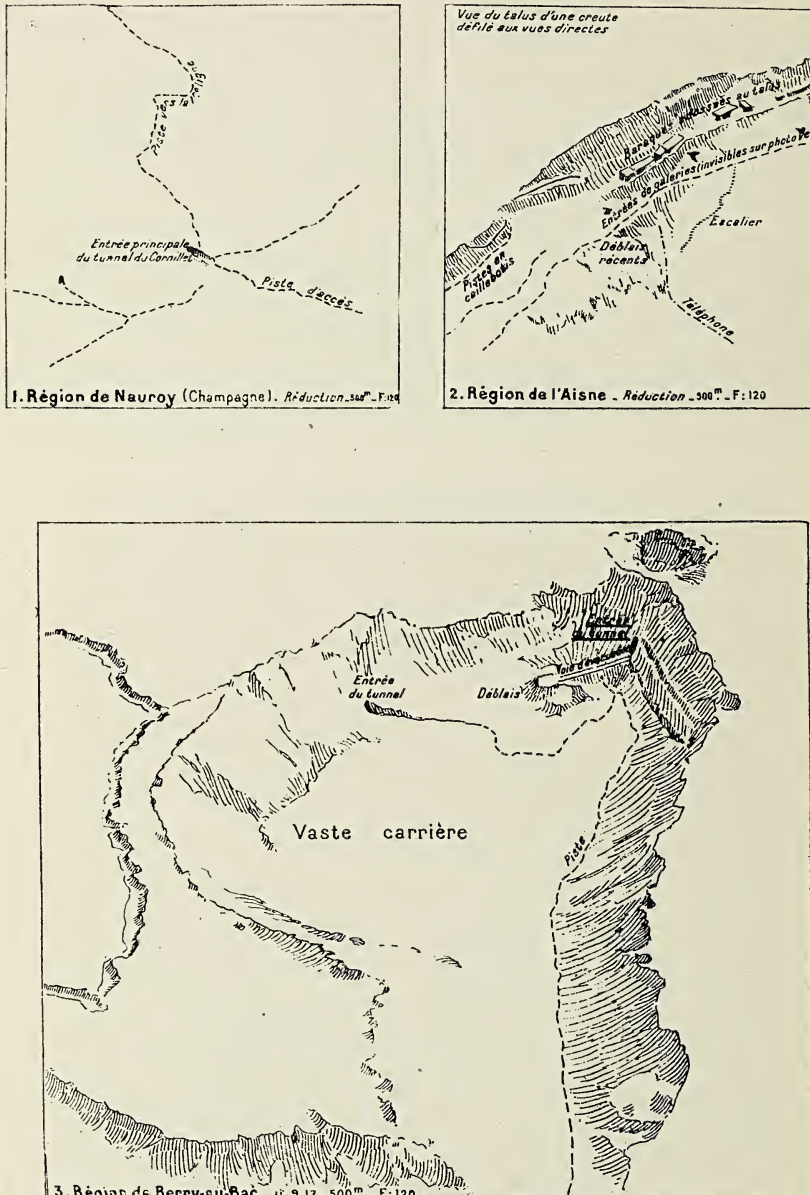
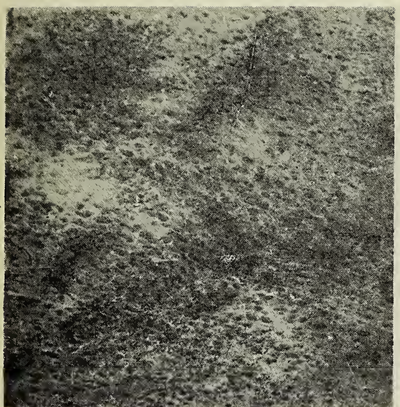


PLATE IX.—Oblique views taken from the enemy rear.



1. Path toward front line.—Principal entrance of Cornillet tunnel.—Path of approach.
2. Bank of excavated earth on edge of ravine defiladed to direct view.—Grating paths.—Barracks against bank.—Gallery entrances (not visible on vertical photo).—Stairs.
3. Tunnel entrance.—Evacuation railway.—Excavated earth.—Vast quarry.—Trail.

PLATE IX.



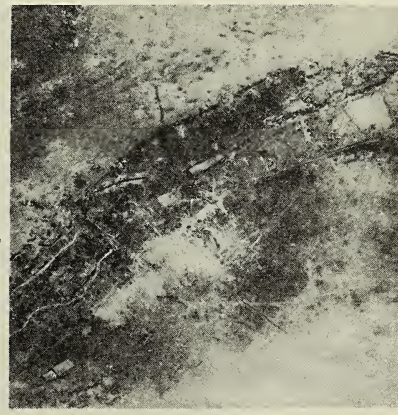
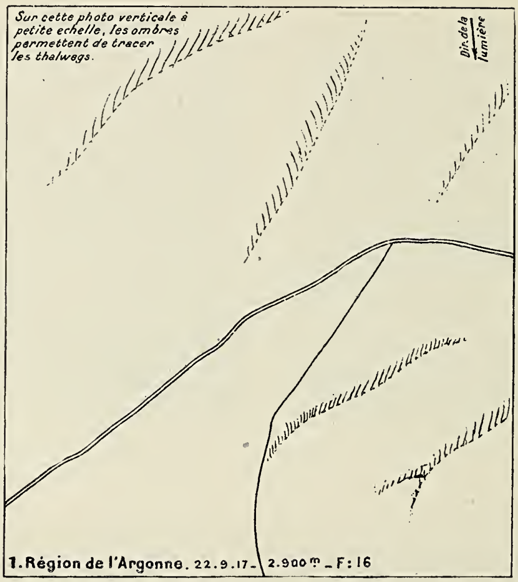
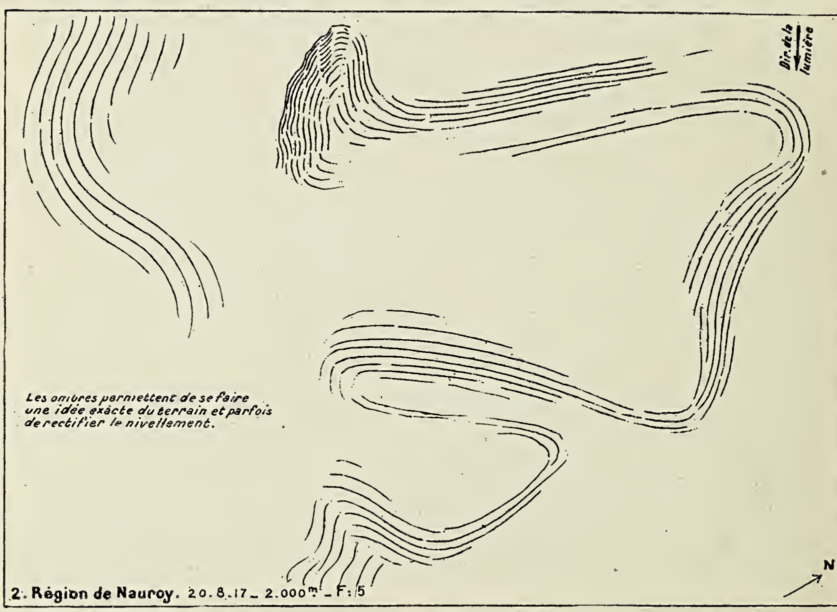


PLATE X.—Studies of altitude from the shadows.





1. On this small-scale vertical photo the shadows show the valley roads.
2. The shadows give a good idea of the terrain and the contour.

PLATE X.

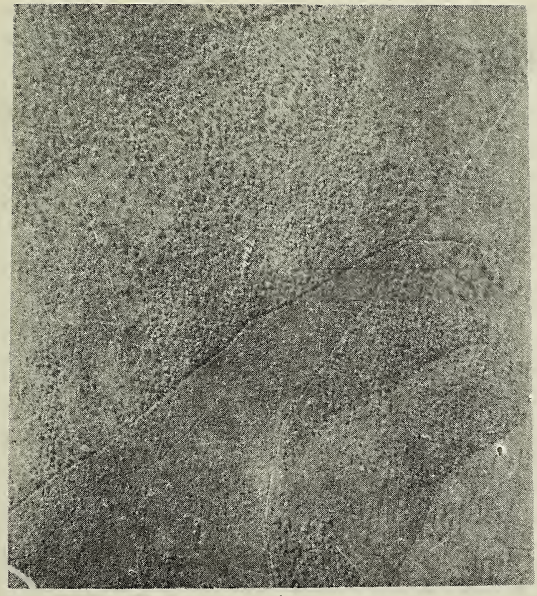
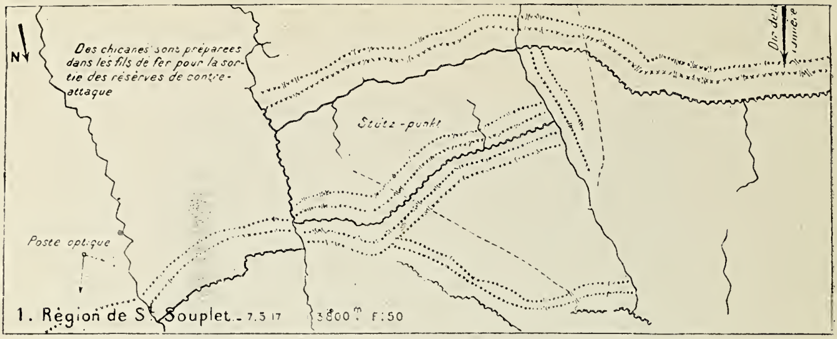
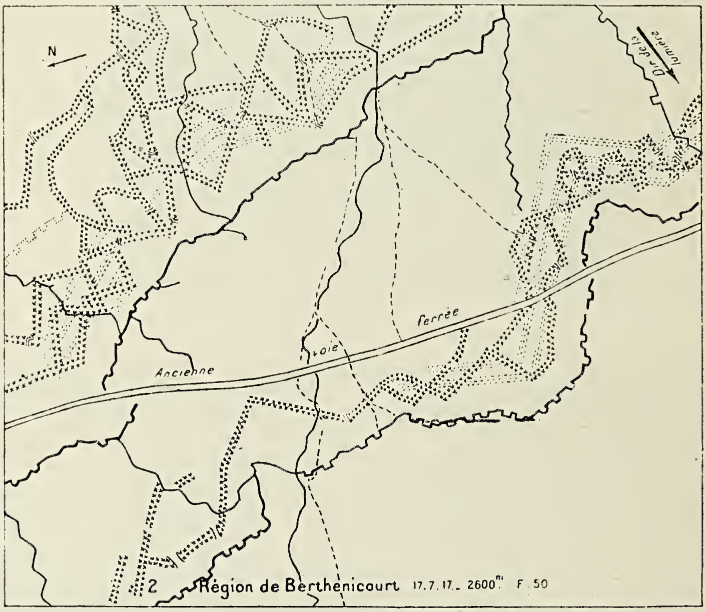
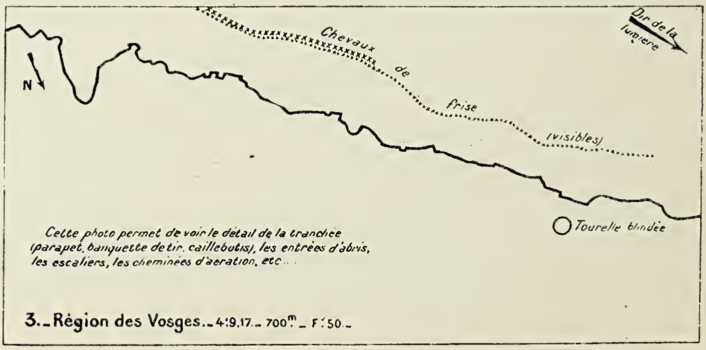


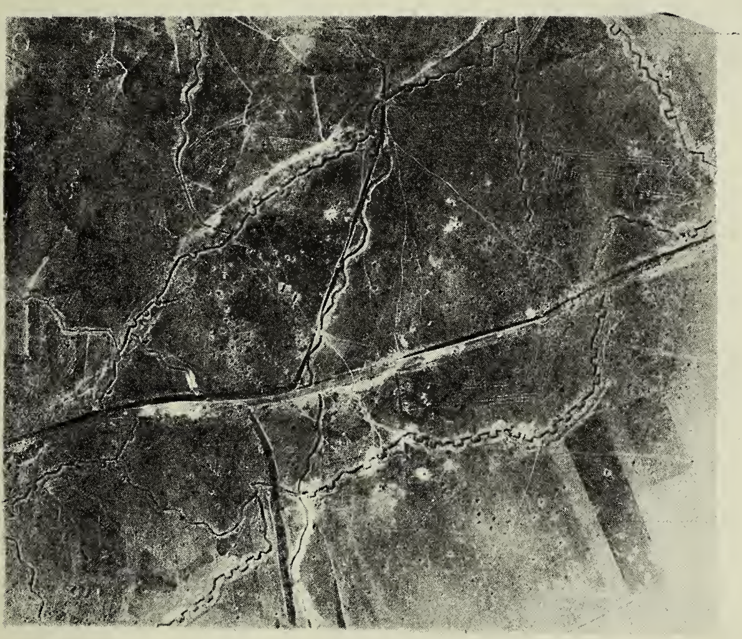
PLATE XI.—Auxiliary defenses (wires, chevaux de frise).







1. Passages are made in the wire entanglements for the counterattack of the reserves.—Supporting point.—Visual signal station.
2. Old railroad.
3. Chevaux de frise (visible).—Armored turret. This photo shows trench details (parapet, firing step, grating), dugout entrances, stairs, airshafts, etc.



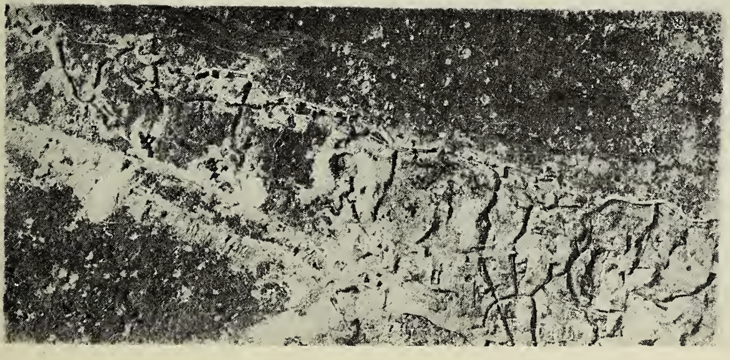
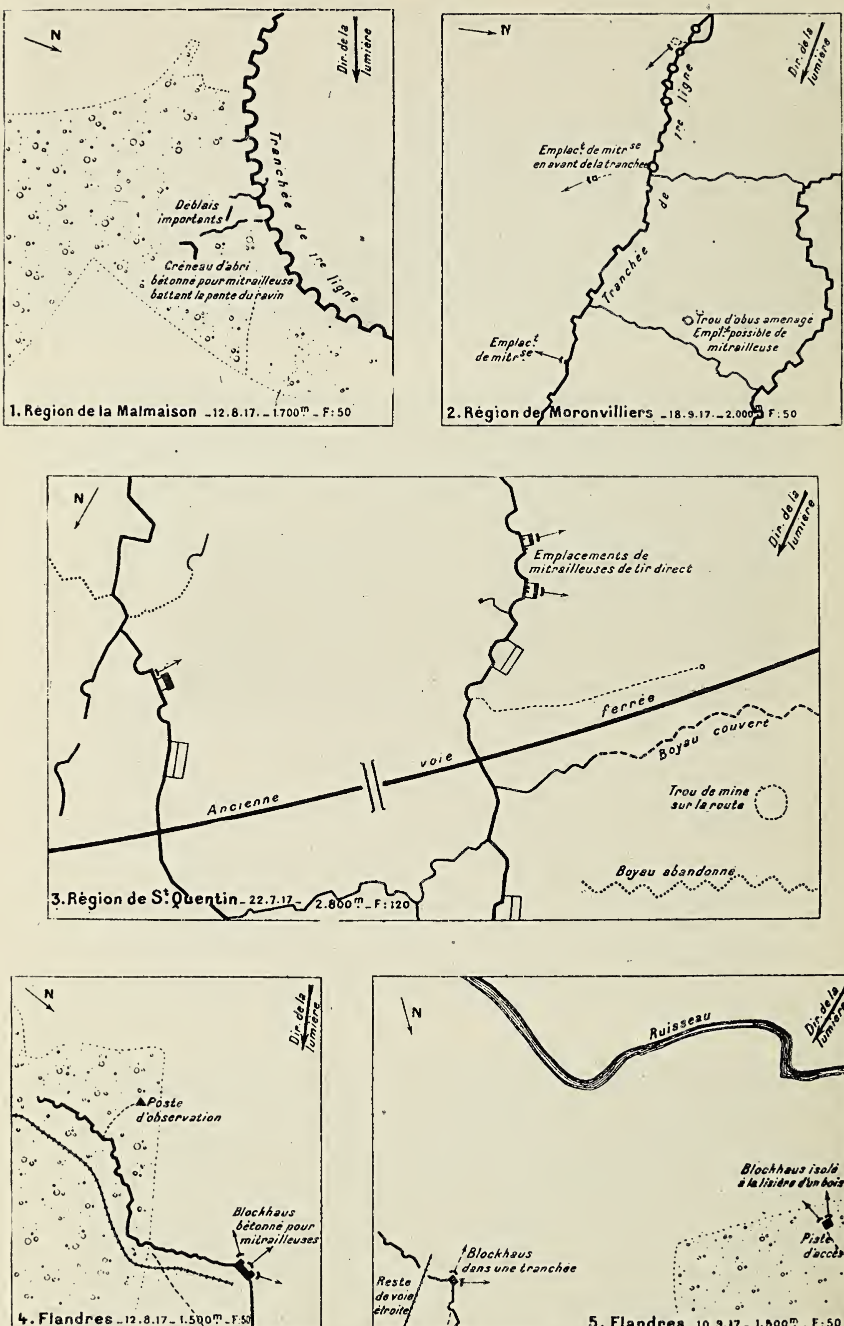


PLATE XII.—Machine guns (1) in trenches, in blockhouses.



1. First line trench.—Large amount of excavated earth.—Battlement of concrete shelter for machine guns on edge of ravine.
2. Machine gun emplacement in front of trench.—Fortified shell hole. Possible location of machine gun.
3. Machine gun emplacements for direct firing.—Old railroad.—Covered boyau.—Shell hole in road.—Abandoned boyau.
4. Observation post.—Concrete blockhouse for machine guns.
5. Stream.—Ruins of narrow-gauge railway.—Blockhouse in trench.—Solitary blockhouse at edge of woods.—Path of approach.

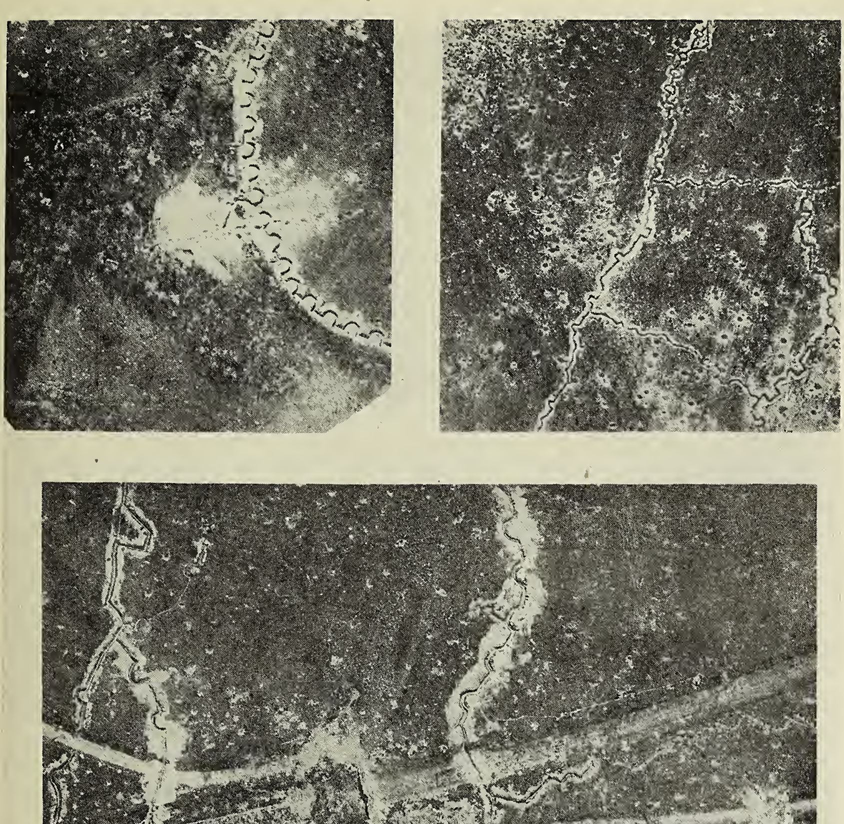
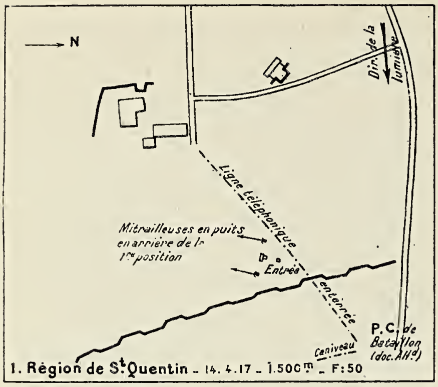
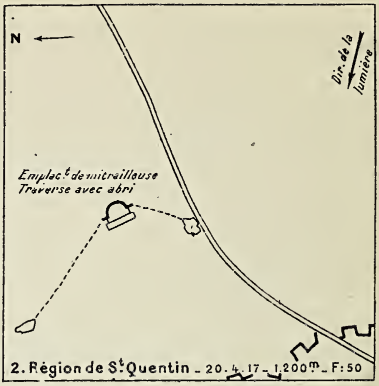
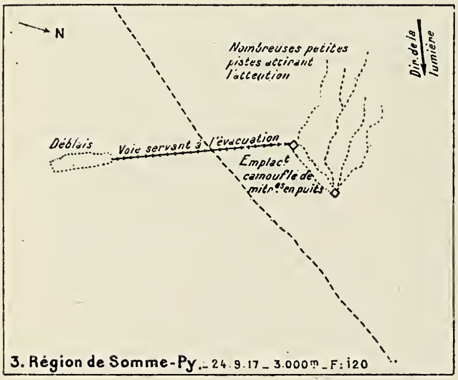
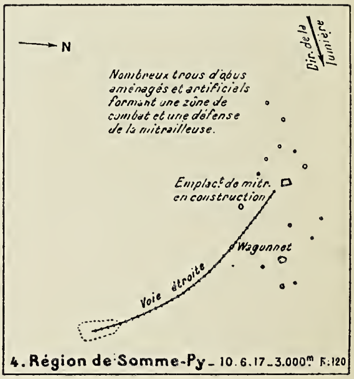


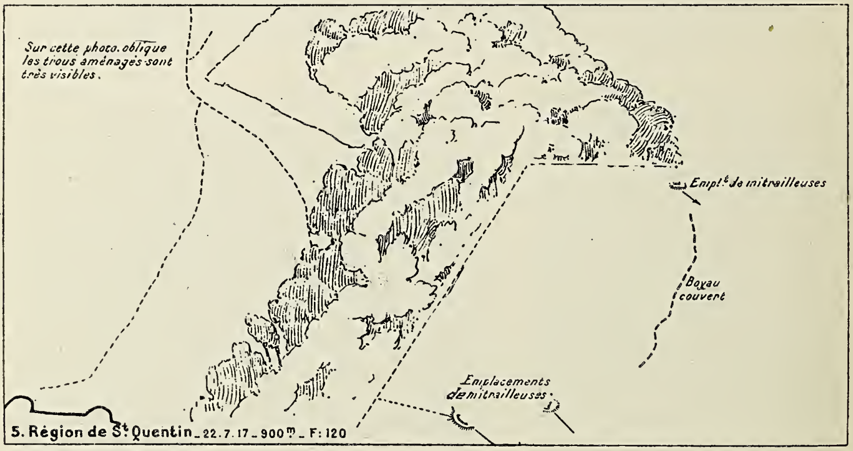
PLATE XIII.—Machine guns (2) outside of trenches, in pits.











1. Machine guns in pits back of front line.—Entrance.—Buried telephone line.—Conduit.—Battalion H. Q (Ger. doc.).
2. Machine gun traverse, with dugout.
3. Numerous small paths.—Excavated earth.—Railway for excavating earth.—Camouflaged emplacement of machine guns in pits.
4. Numerous fortified shell and artificial holes, forming fighting zone and machine-gun defense.—Machine-gun emplacement being constructed.—Narrow-gauge railway.—Small car.
5. Fortified shell holes are very visible.—Machine-gun emplacement.—Covered boyau.

PLATE XIII.

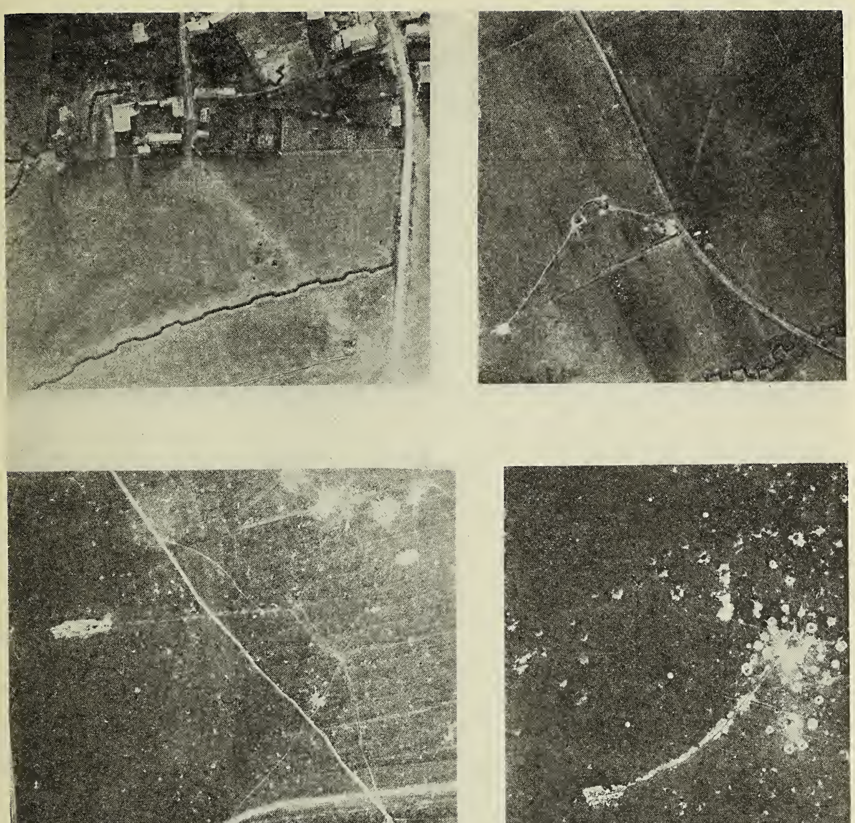
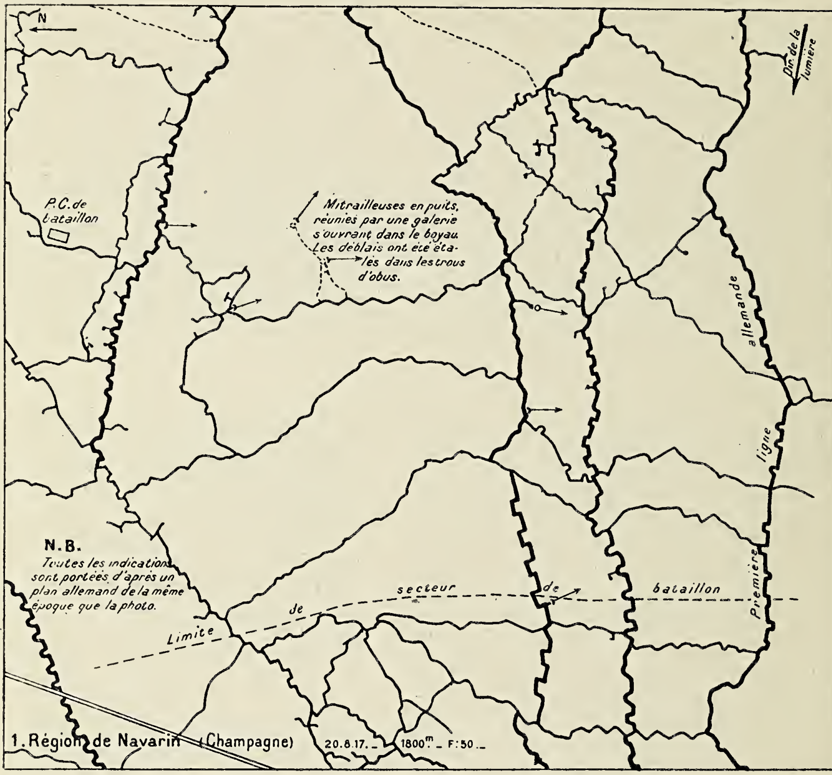
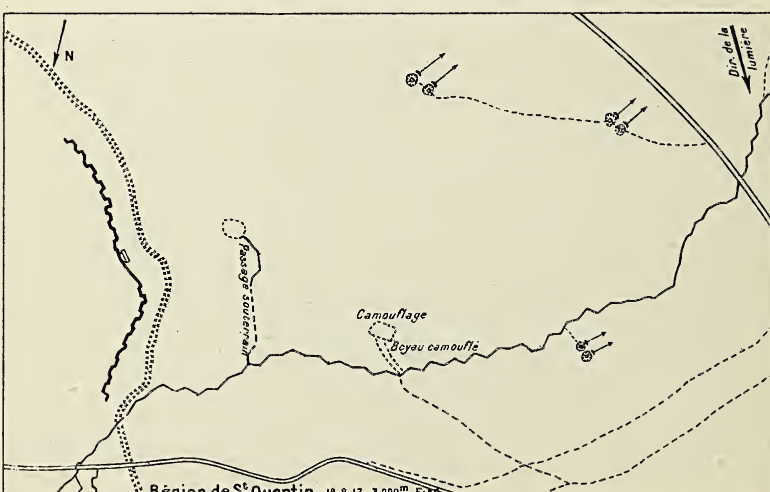


PLATE XIV.—Machine guns (3) of a sector.

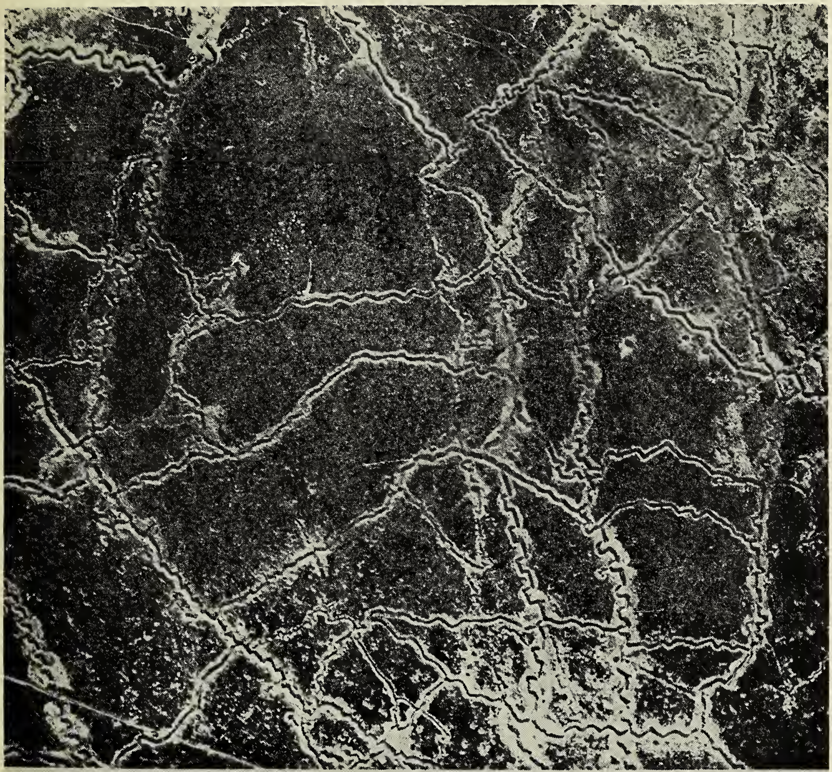




1. Battalion headquarters.—Machine guns in pits connected by gallery opening into boyau. Excavated earth was spread in shell holes.—German front line.—Limit of battalion sector.

N. B.—All the indications are according to a German plan of the same period as the photo.

PLATE XIV.



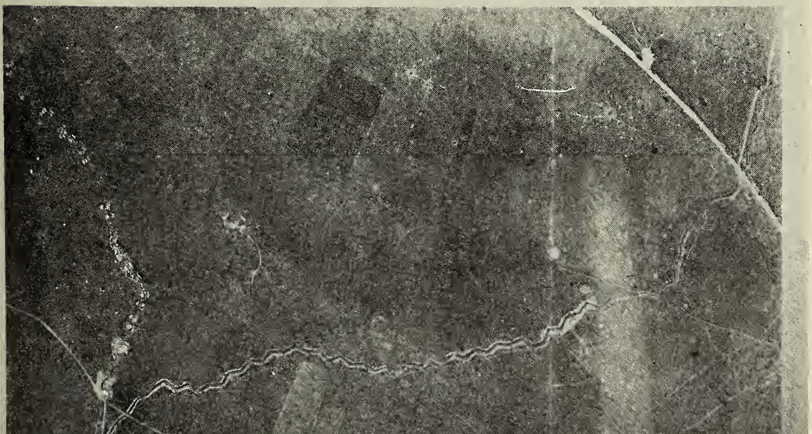
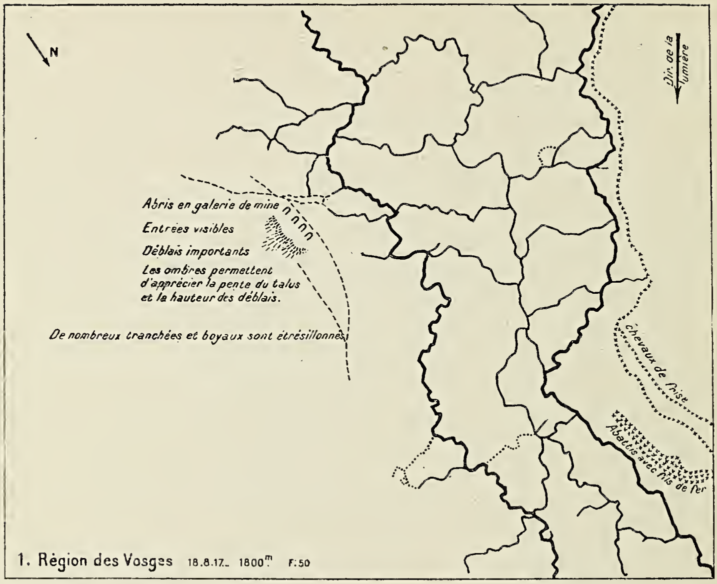
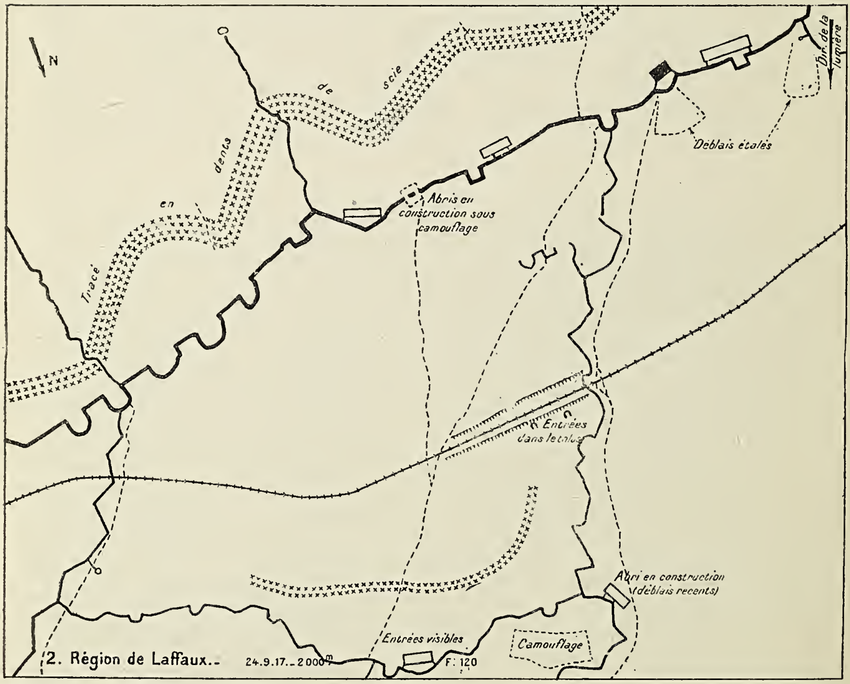


PLATE XV.—Shelters (1) underground dugouts.





1. Underground dugouts; entrances visible.—Large dirt heaps; shadows show slope of bank and height of dirt heap.—Numerous trenches and boyaus crisscross.—Abattis with wires.
2. Saw teeth tracing.—Spread out dirt.—Entrances in bank.—Dugouts being made (recent dirt heaps).

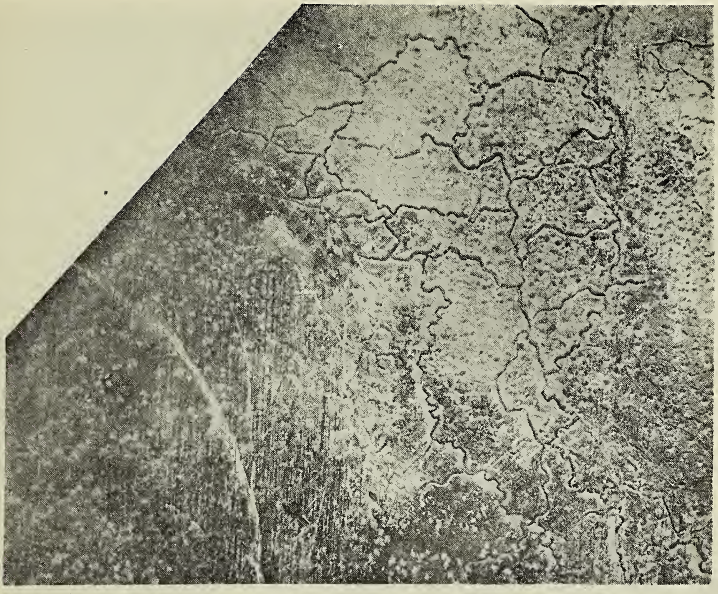
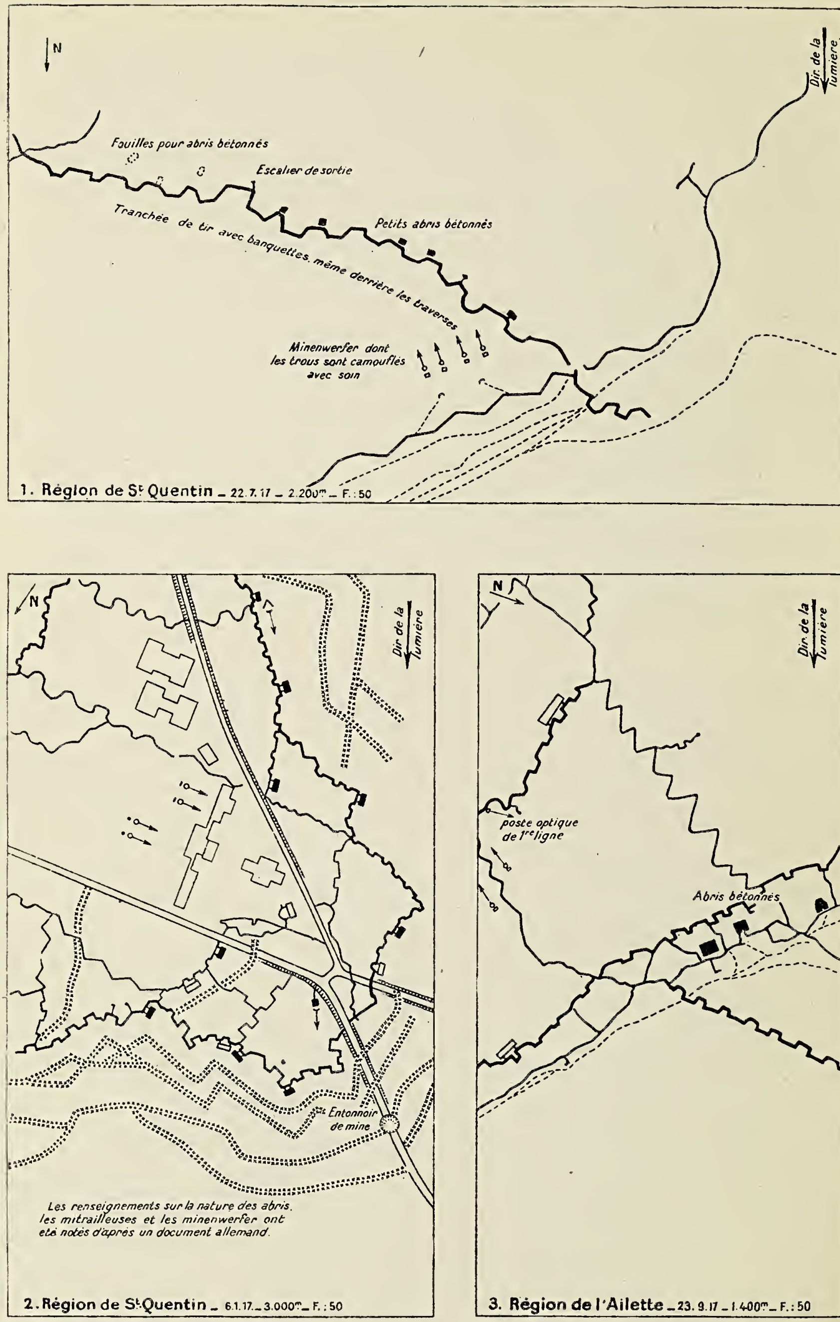


PLATE XVI.—Shelters (2) reinforced.



1. Excavations for concrete shelters.—Exit stairway.—Small concrete shelters.—Firing trench with banquettes, even back of the traverses.—Trench mortors with pits carefully camouflaged.
2. Information on nature of shelters, machine guns and trench mortars has been noted in accordance with a German document.
3. Visual signaling post of first line.—Concrete shelters.

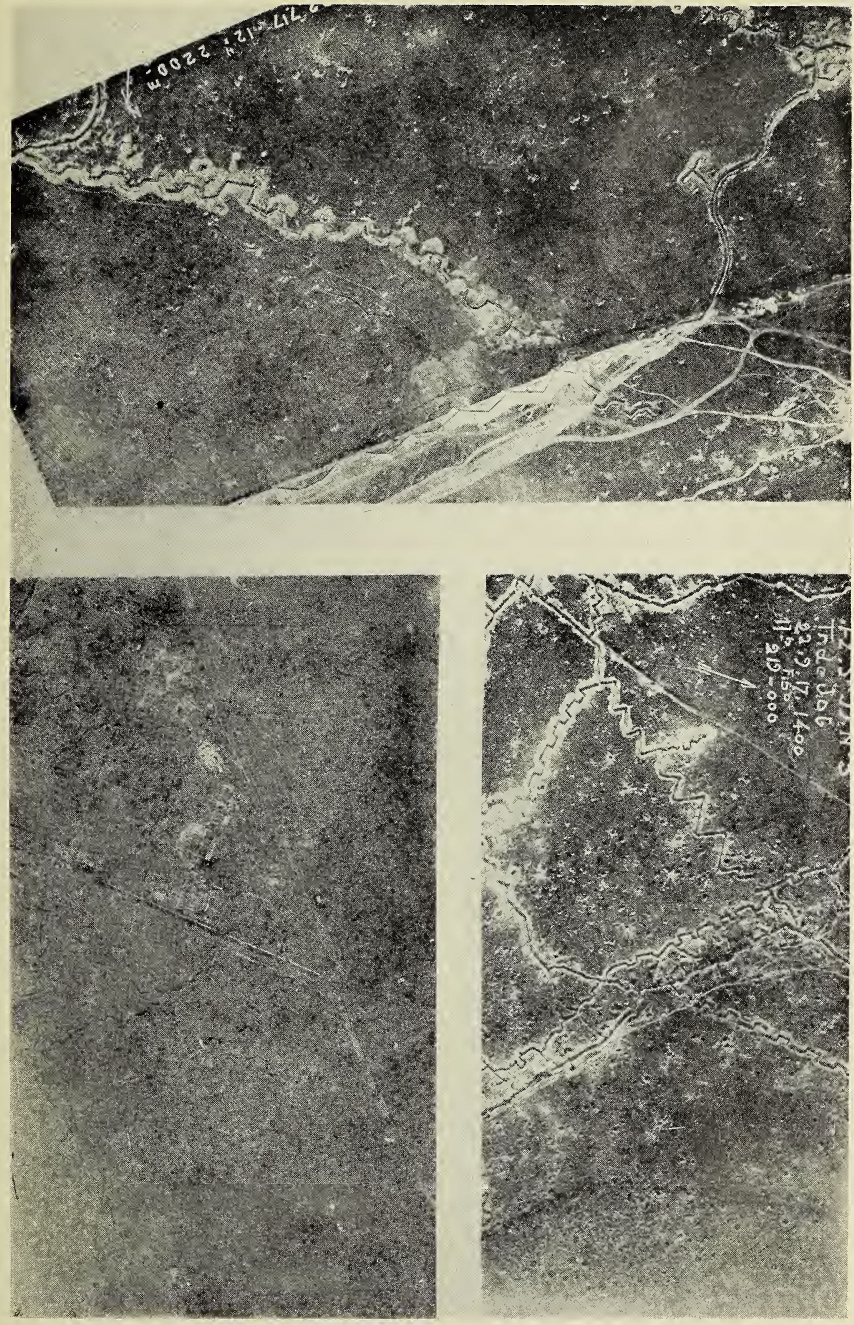
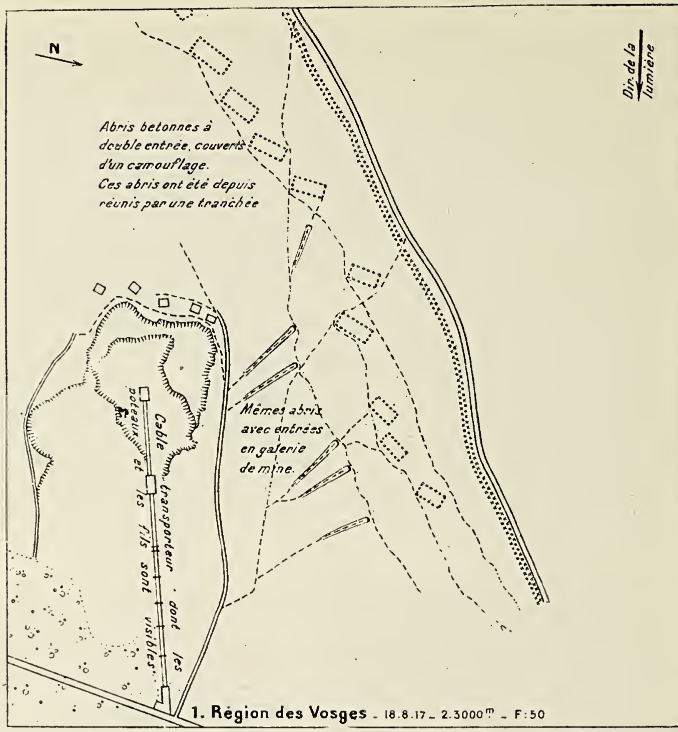
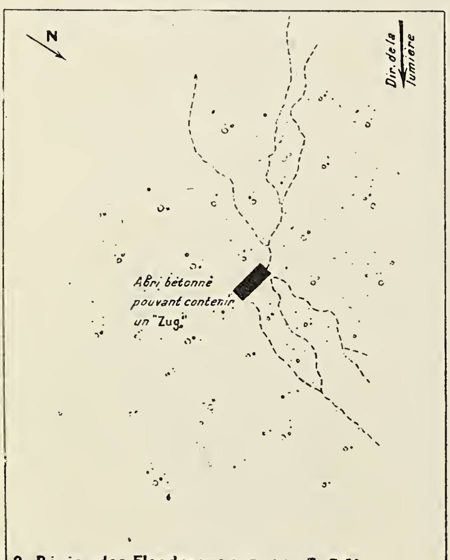


PLATE XVII.—Shelters (3).



1. Région des Vosges - 18.8.17 - 2.3000m - F:50



2. Région des Flandres - 9.9.17 - 1.500m - F:50

3. Région des Vosges - 26.1.17 - 3.000m - F: 26

1. Concrete shelters with double entrance, camouflaged. These shelters have since been connected by a trench.—Same shelters with underground entrances.—Transporting cable, poles and wires visible.
2. Concrete shelters, able to hold a "Zug."
3. German lines.—French lines.—The snow photos give some idea of the life and circulation. The frequented trenches and boyaus appear dark, the others light. The warmth of the heated shelters causes the snow above to melt. (See in the French lines the shelters marked with a point.) —E. Flow of water indicating large shelter.—Shadows on snow show contour of field.

PLATE XVII.

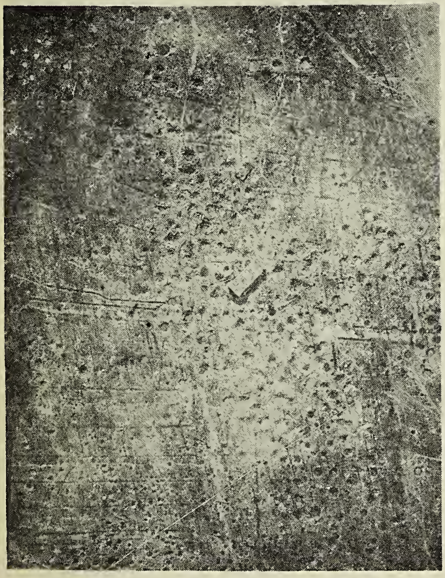
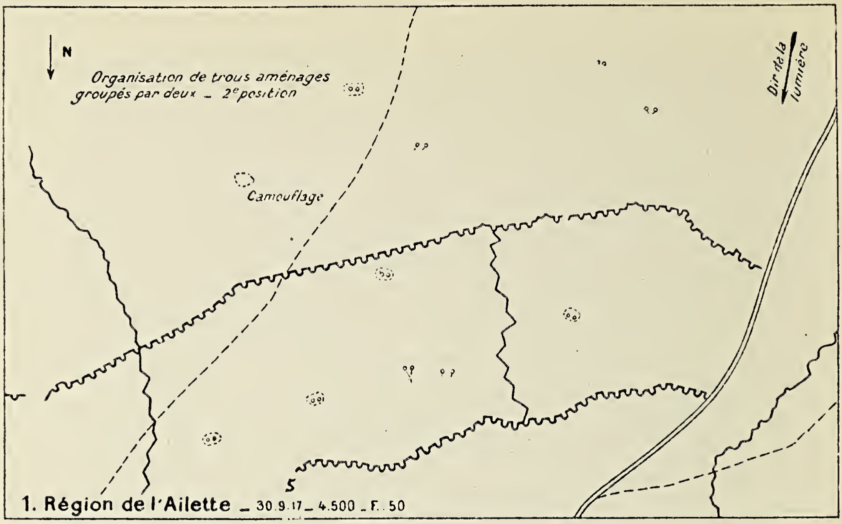
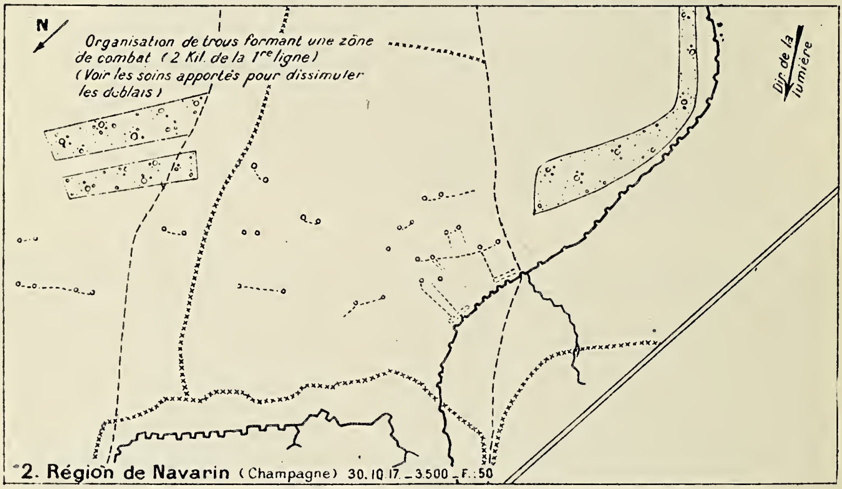
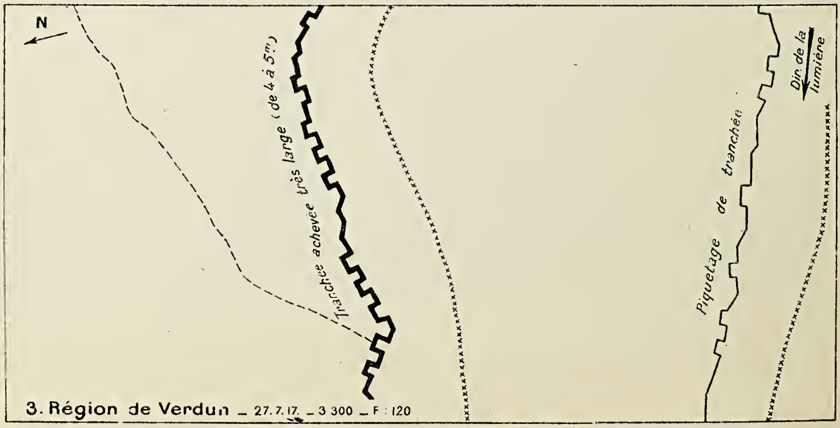


PLATE XVIII.—Organization types (1) shell holes, wide trenches.







1. Organization of fortified holes in groups of two.
2. Organization of holes forming one fighting zone (2 km. of front line). (Note pains taken to conceal dirt.)
3. Very wide trench (4 to 5 meters).—Tracing for trench.

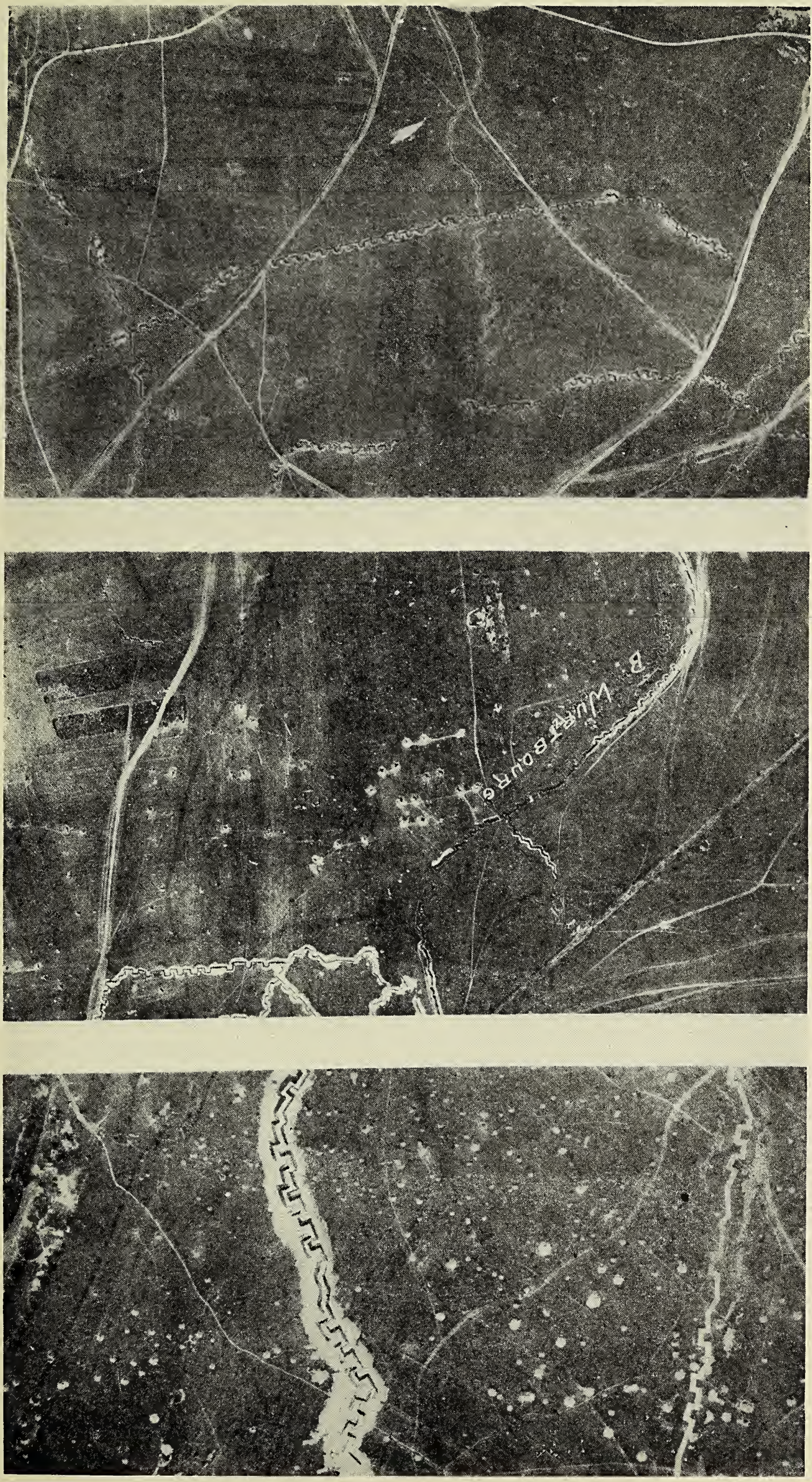
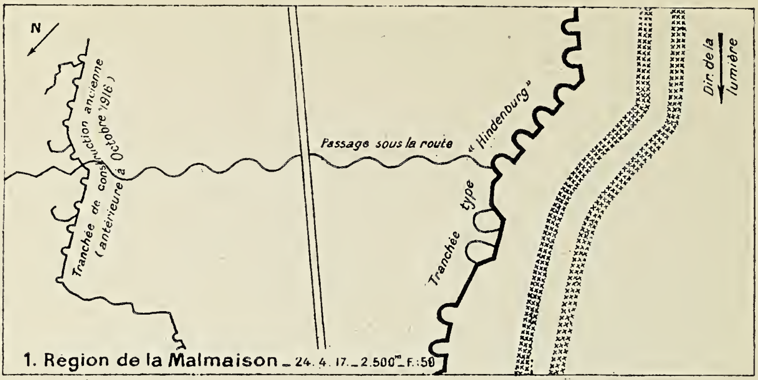
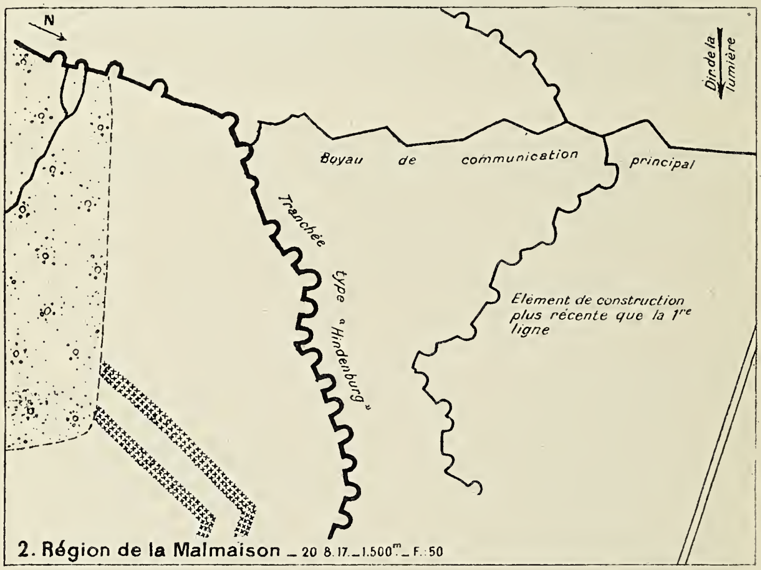
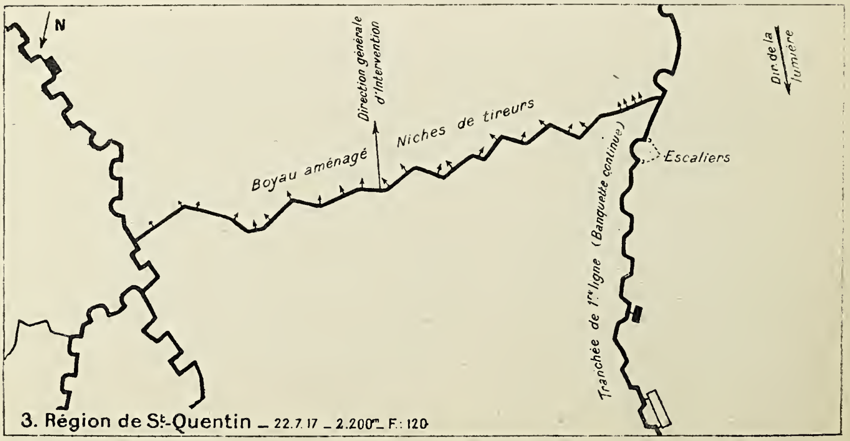

B. WURZBOURG

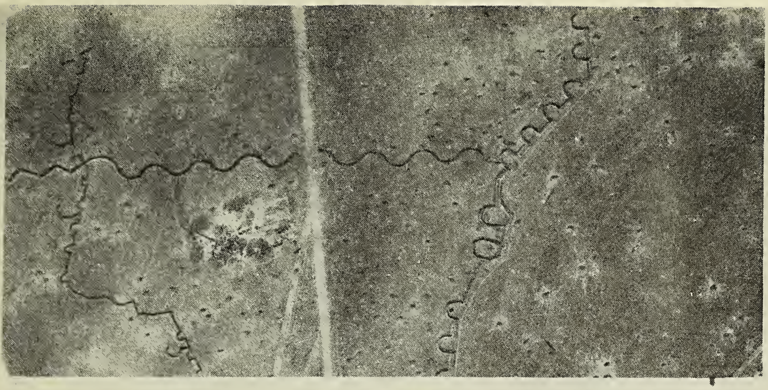
PLATE XIX.—Organization types (2) trenches, boyaus.

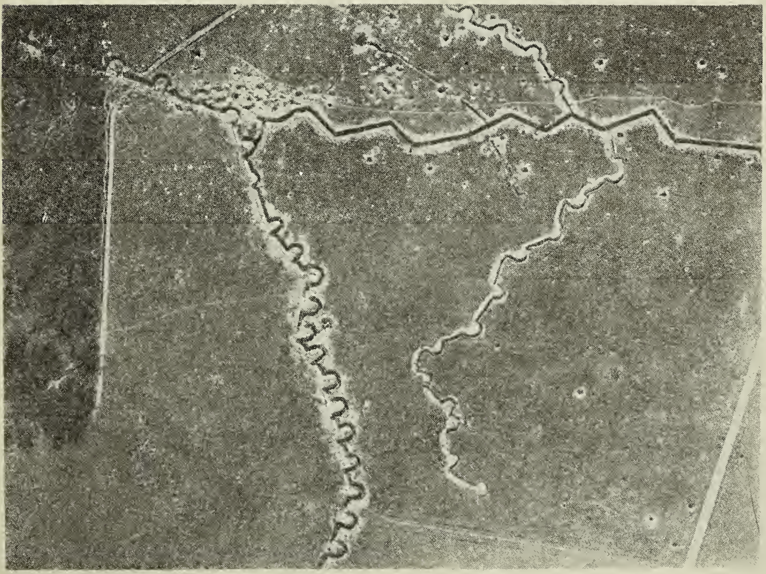






1. Trench of old construction (previous to October, 1916).—Passage under road.—Trench of Hindenburg type.
2. Principal communication trench.—Trench of Hindenburg type.—Element of more recent construction than the front line.
3. General direction of intervention.—Boyau provided with sharpshooters' niches.—First line trench (continuous banquette).—Stairs.





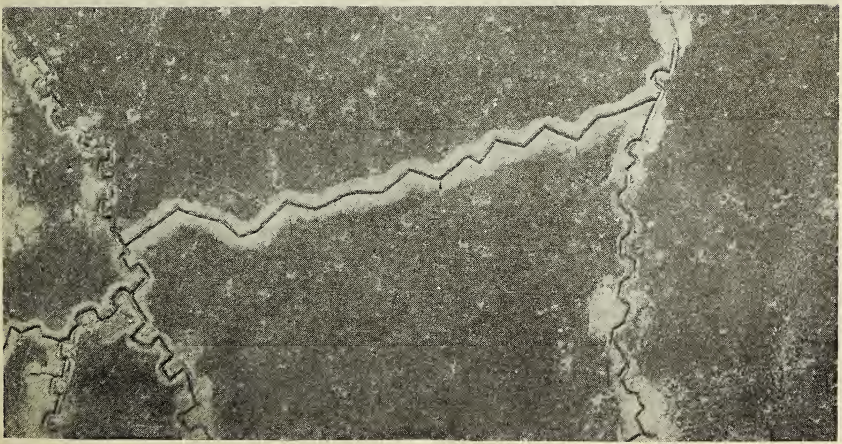
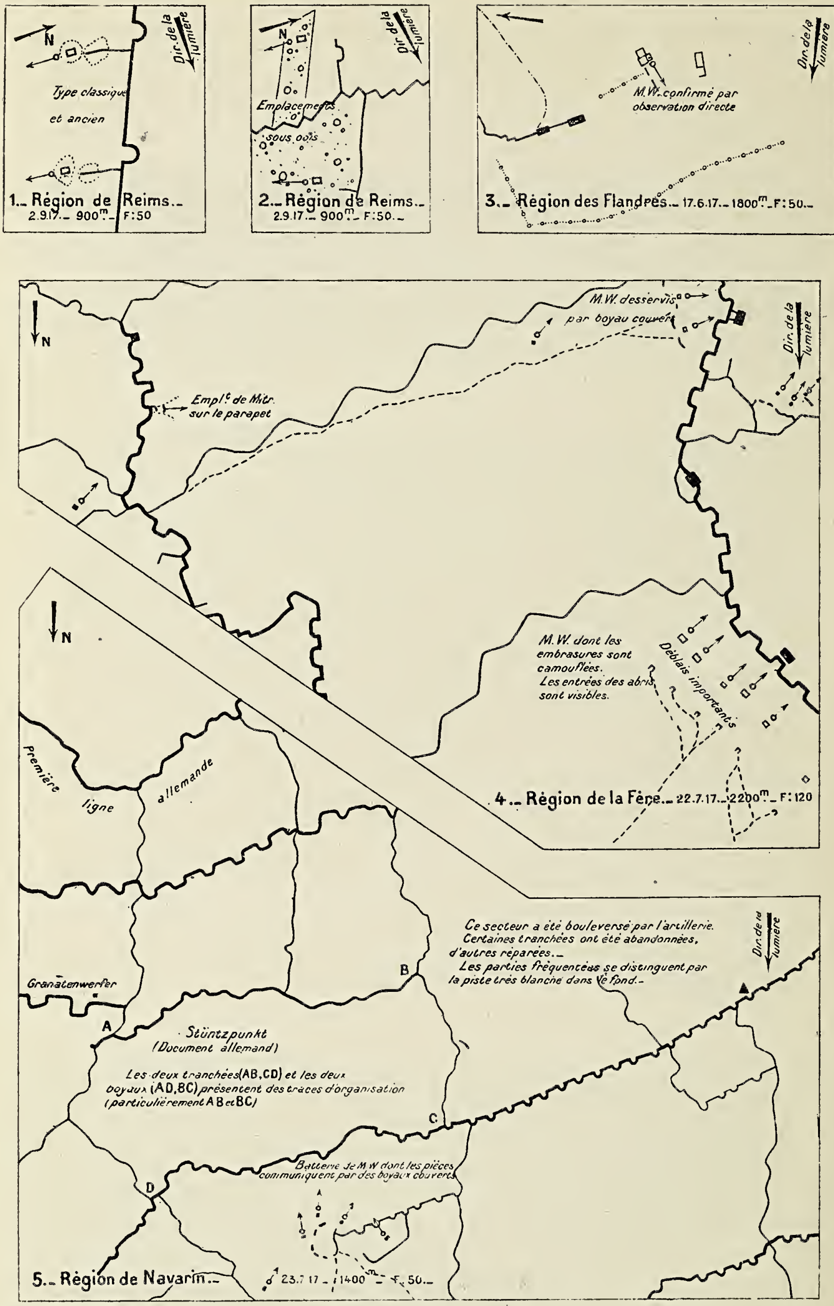


PLATE XX.—Trench mortars (Minenwerfer).



1. Classic and ancient type.
2. Emplacements in woods.
3. Howitzers confirmed by direct observation.
4. Machine-gun emplacement on parapet.—Howitzer served by covered trench.—Howitzer with camouflaged embrasures. Dugout entrances visible.—Large quantities of excavated earth.
5. German front line.—Grenade thrower.—This sector has been torn up by artillery. Same trenches have been abandoned and others repaired. Frequented parts are distinguished by very white trail in background.—Supporting point (Ger. doc.).—Both trenches and both boyaux (AD, BC) show traces of organization (especially AB and BC).—Howitzer battery with pieces connected by covered trenches.

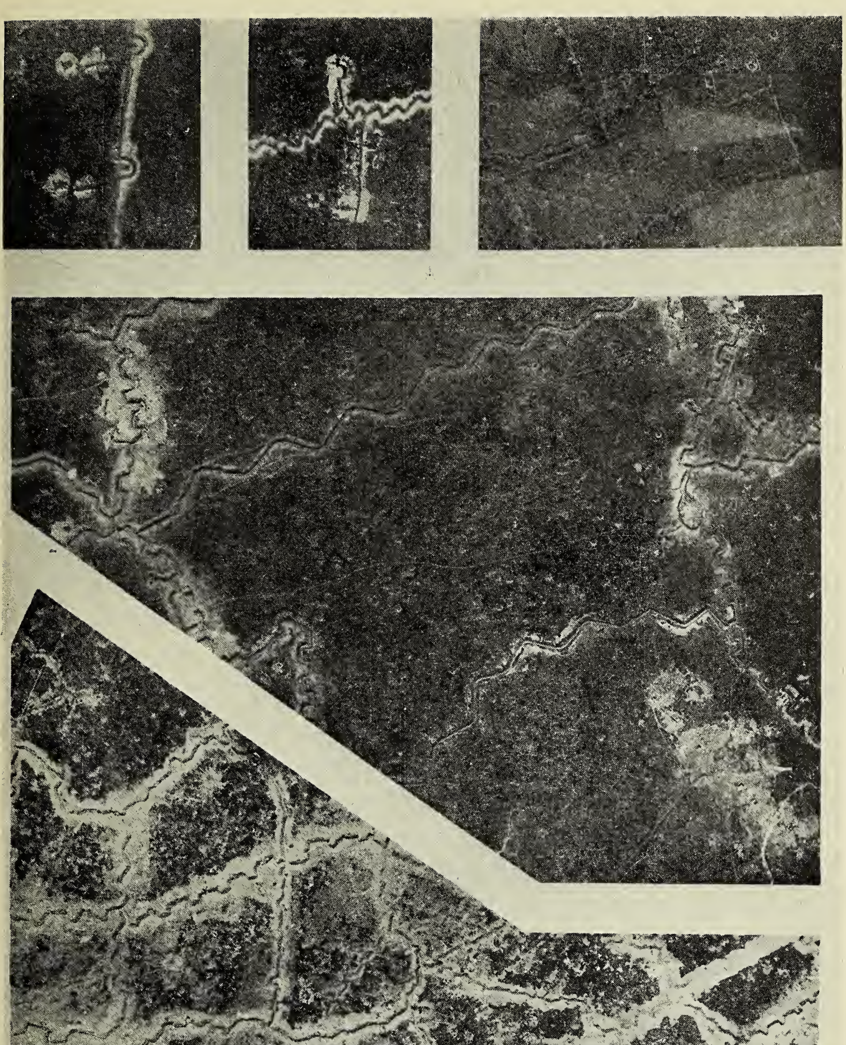
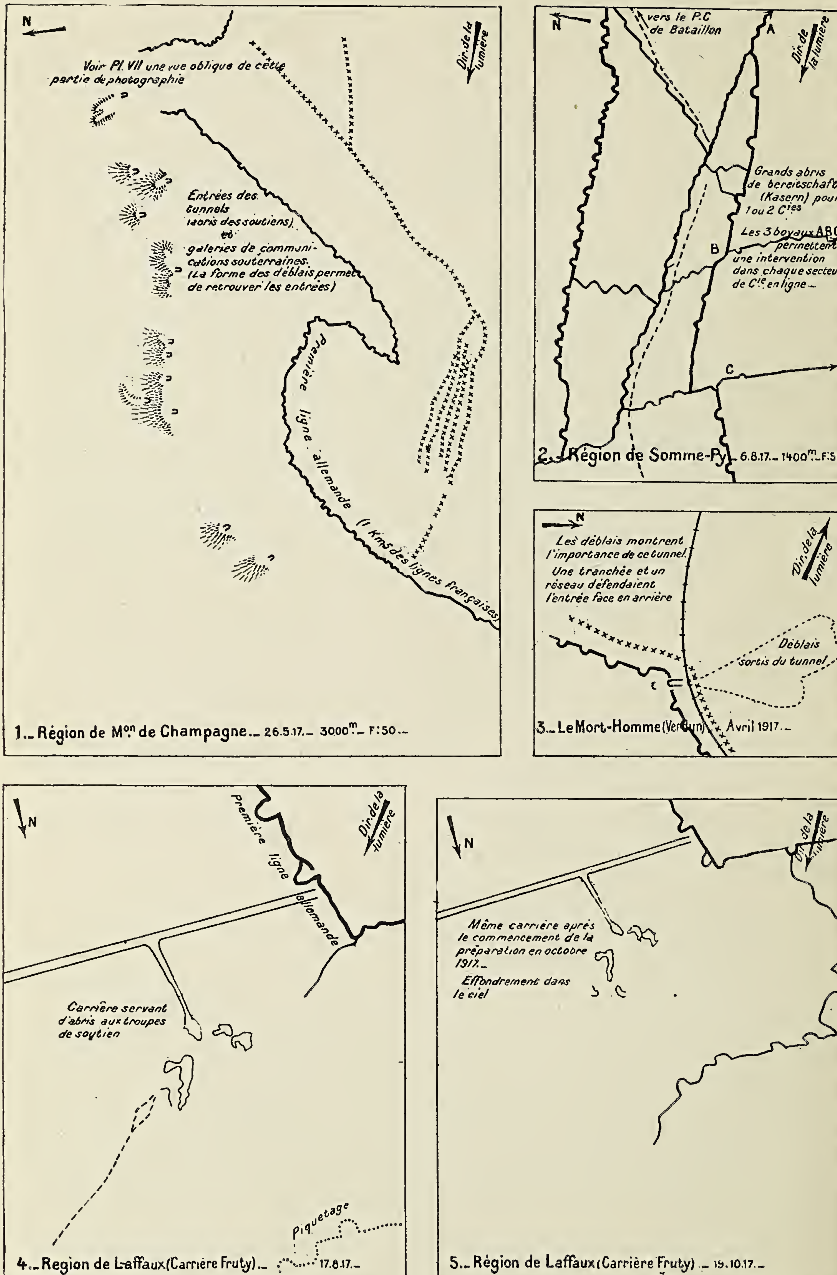


PLATE XXI.—Concentration trenches—Tunnels.



1. See Pl. VII, an oblique view of this part of photo.—Tunnel entrances (shelters of supporting troops) and underground galleries. (Shape of dirt bank makes it possible to discover entrances.)
2. Toward battalion headquarters.—Large reserve dugouts for one or two companies.—The three boyaus A, B, C, enable the intervention in each sector of the company in line.
4. Quarry serving as shelter for supporting troops.—German front line.—Tracing for trench.
5. Same quarry after beginning of artillery preparation in October, 1917.

PLATE XXI.

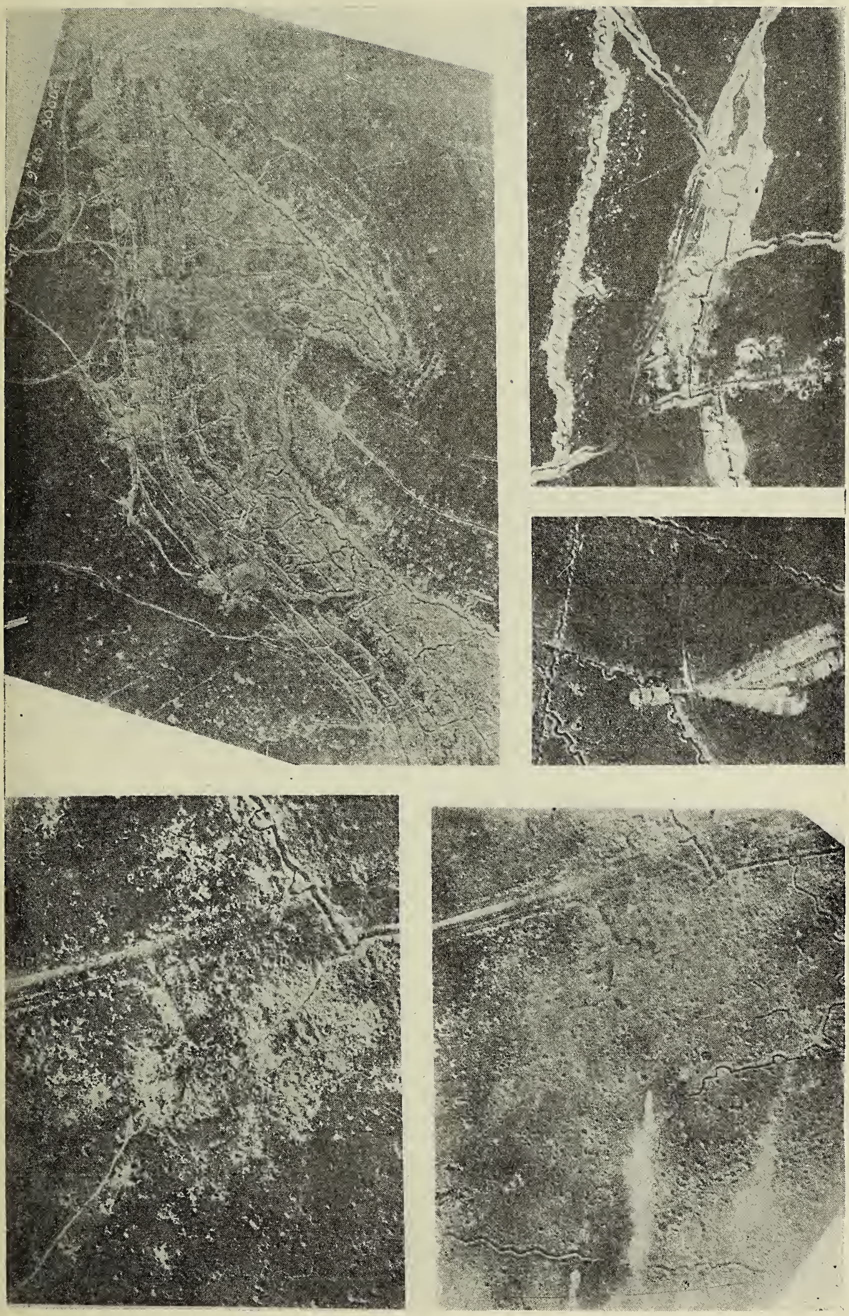
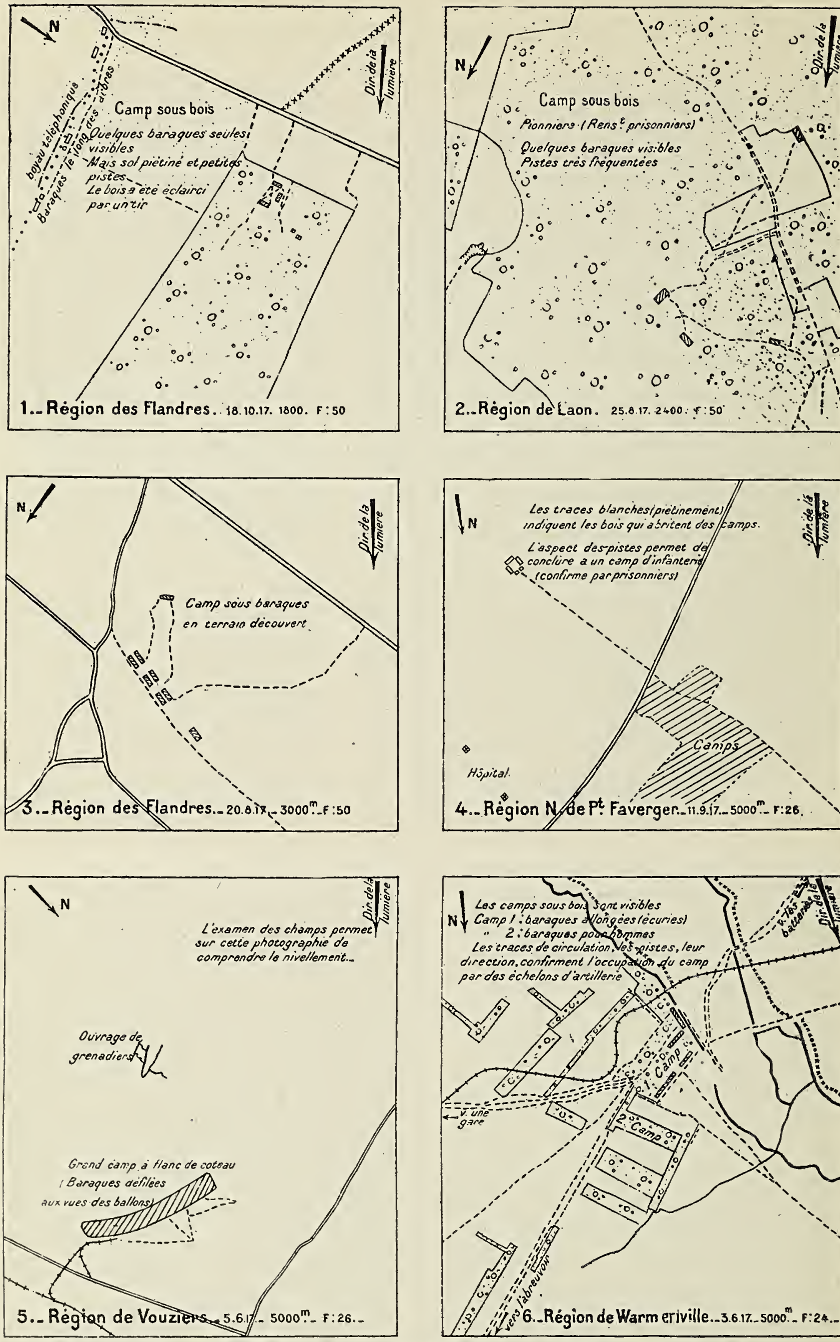


PLATE XXII.—Rest camps.



1. Telephone trench.—Barracks under trees.—Camp in woods. Only a few barracks visible, but trampled ground and small paths.—Woods have been cleared by a bombardment.
2. Camp in woods.—Pioneers (information from prisoners).—Some barracks visible.—Numerous paths.
3. Barracks in open field.
4. Light spots (trampling) indicate that woods shelter camps.—Appearance of paths indicates infantry camp (confirmed by prisoners).
5. Examination of fields enables one to understand the leveling.—Grenadier works.—Large camp in side of hill (barracks defiladed from view of balloons).
6. Camps in woods are visible. Camp 1: Elongated barracks (stables). Camp 2: Barracks for men. Traces of circulation; trails; their direction; confirm occupation by artillery echelons.—Toward station.—Toward watering place.

PLATE XXII.

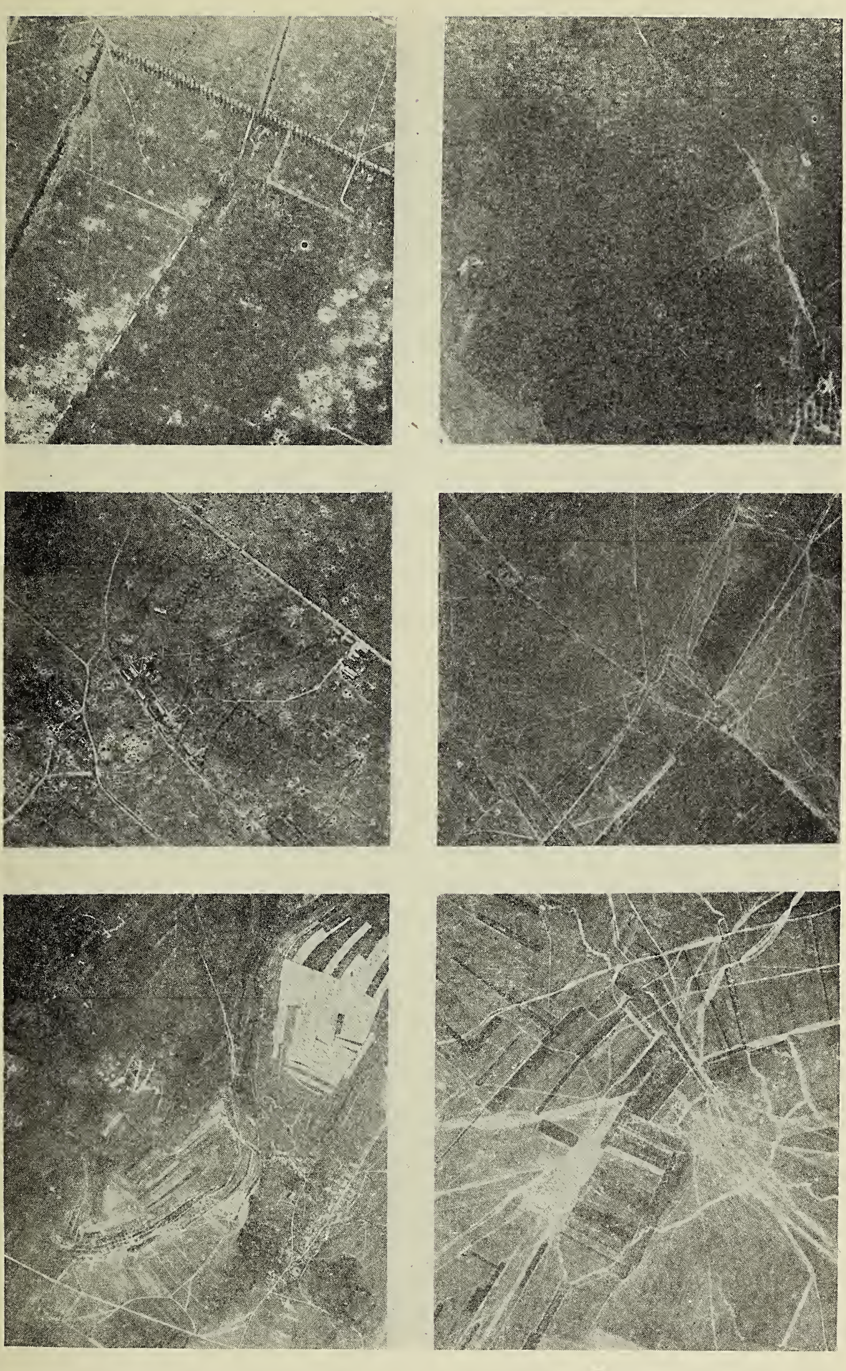
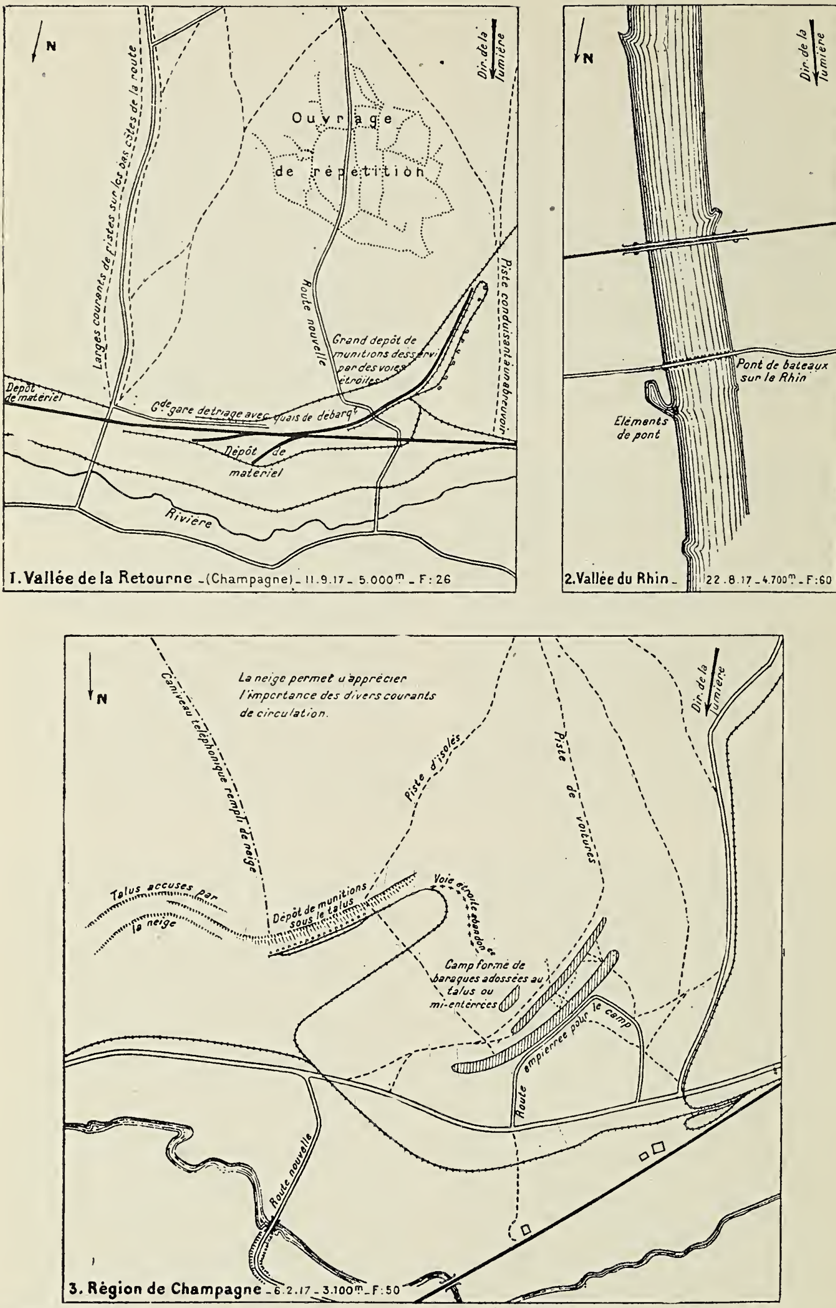
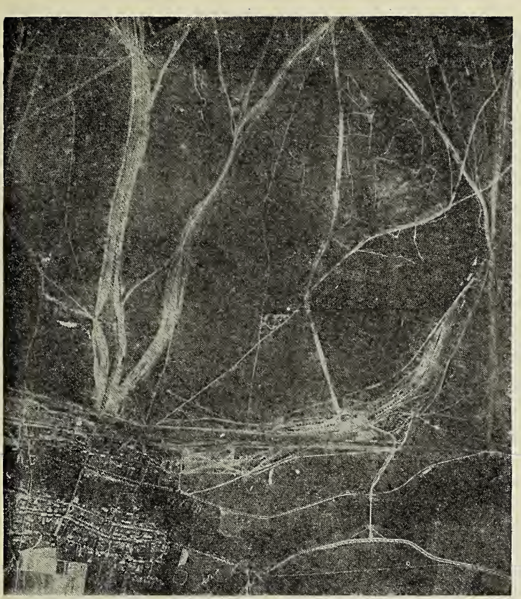


PLATE XXIII.—Roads (1) paths, highways, bridges.



1. Works of repetition.—Wide rows of paths on lower side of road.—Supply depot.—Large terminal station with unloading platform.—New road.—Large munition depot served by narrow-gauge railways.—Trail leading to watering place.
2. Pontoon bridge across the Rhine.—Elements of bridge.
3. The snow makes it possible to estimate the importance of the various currents of circulation.—Telephone conduit filled with snow.—Dirt banks brought out by snow.—Munition depot under bank.—Abandoned narrow-gauge railway.—Footpath.—Carriage road.—Camp of barracks against the bank, or half-buried.—Macadamized road for camp.—New road.

PLATE XXIII.



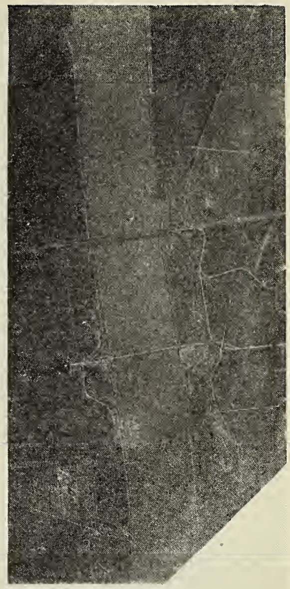
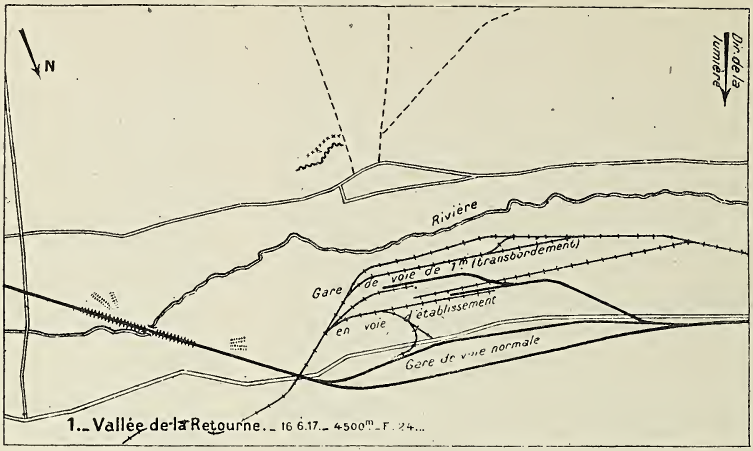
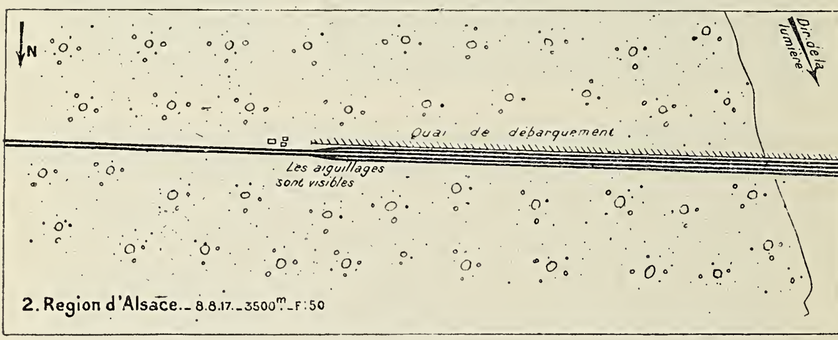
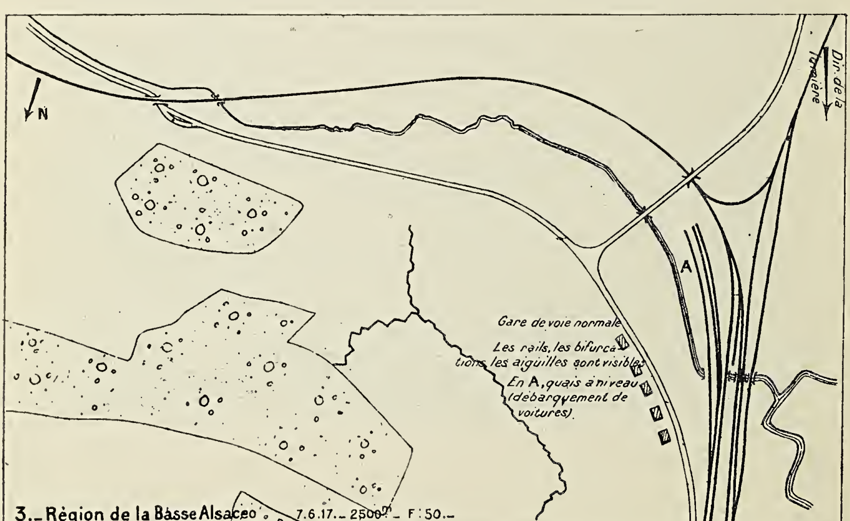


PLATE XXIV.—Roads (2) railroads, stations.

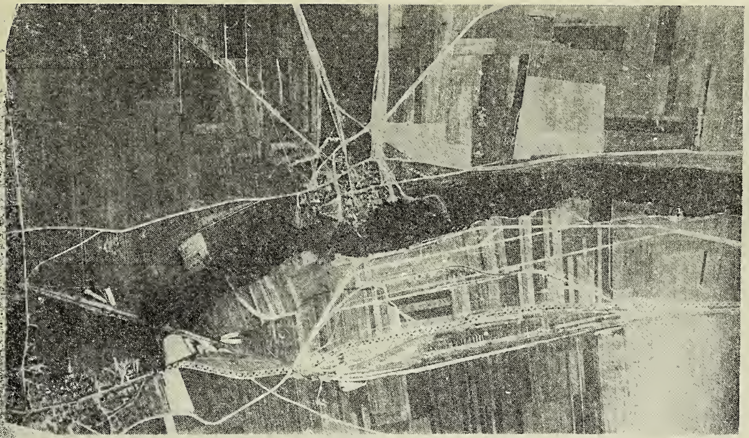


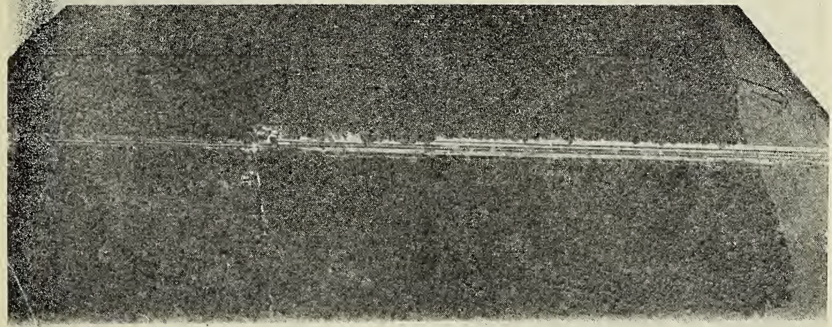




1. Station of 1 m. railway (transshipping) in course of construction.—Station of standard gauge railroad.
2. Unloading platform.—Switches are visible.
3. Station of standard gauge road.—Rails, forks, switches are visible; at A, platforms for unloading cars.

PLATE XXIV.





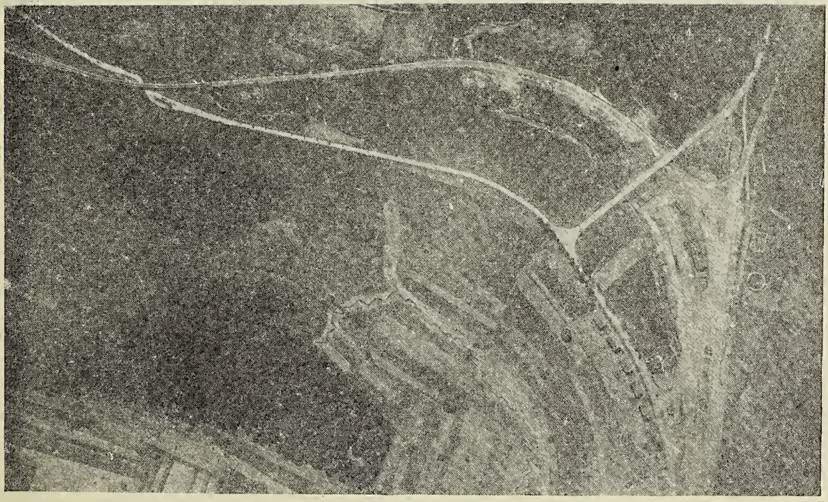
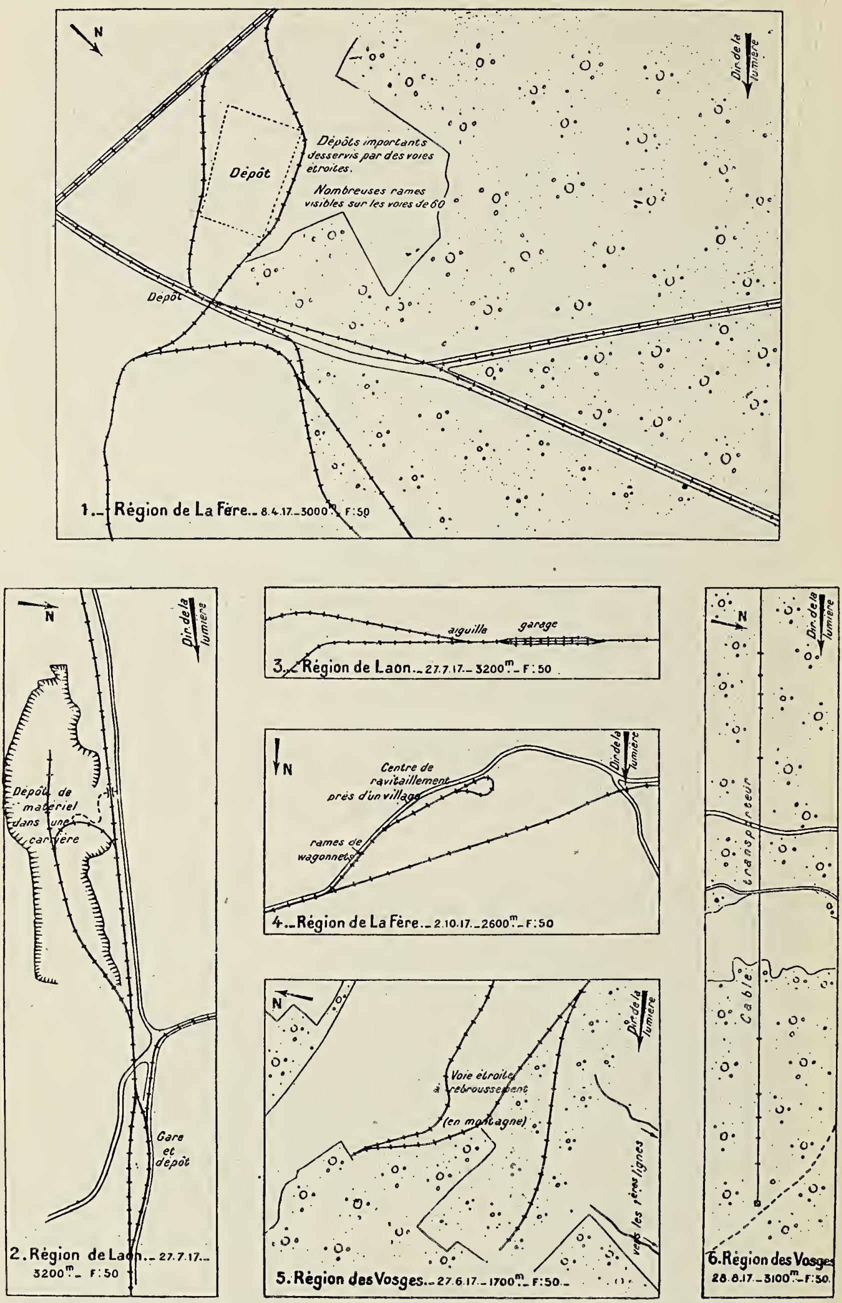


PLATE XXV.—Roads (3) narrow-gauge railways, mountain railways, supply depots.



1. Important depots served by narrow-gauge railways.—Numerous cars visible on 60 cm. roads.
2. Supply depot in a quarry.—Station and depot.
3. Spur track.—Turnout.
4. Replenishing center near village.—Trains of cars.
5. Narrow-gauge railway with return (in mountains).—Toward front lines.
6. Transporting cable.

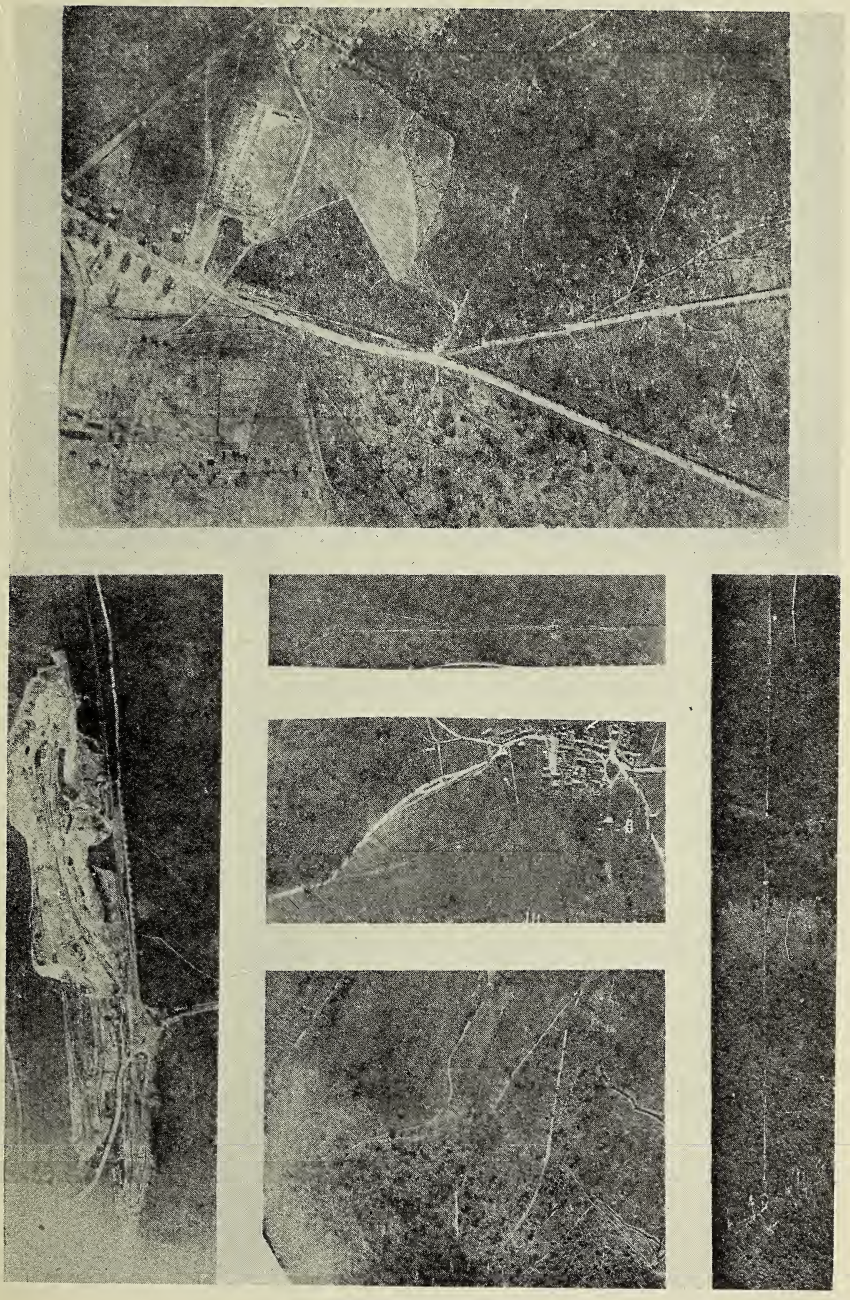
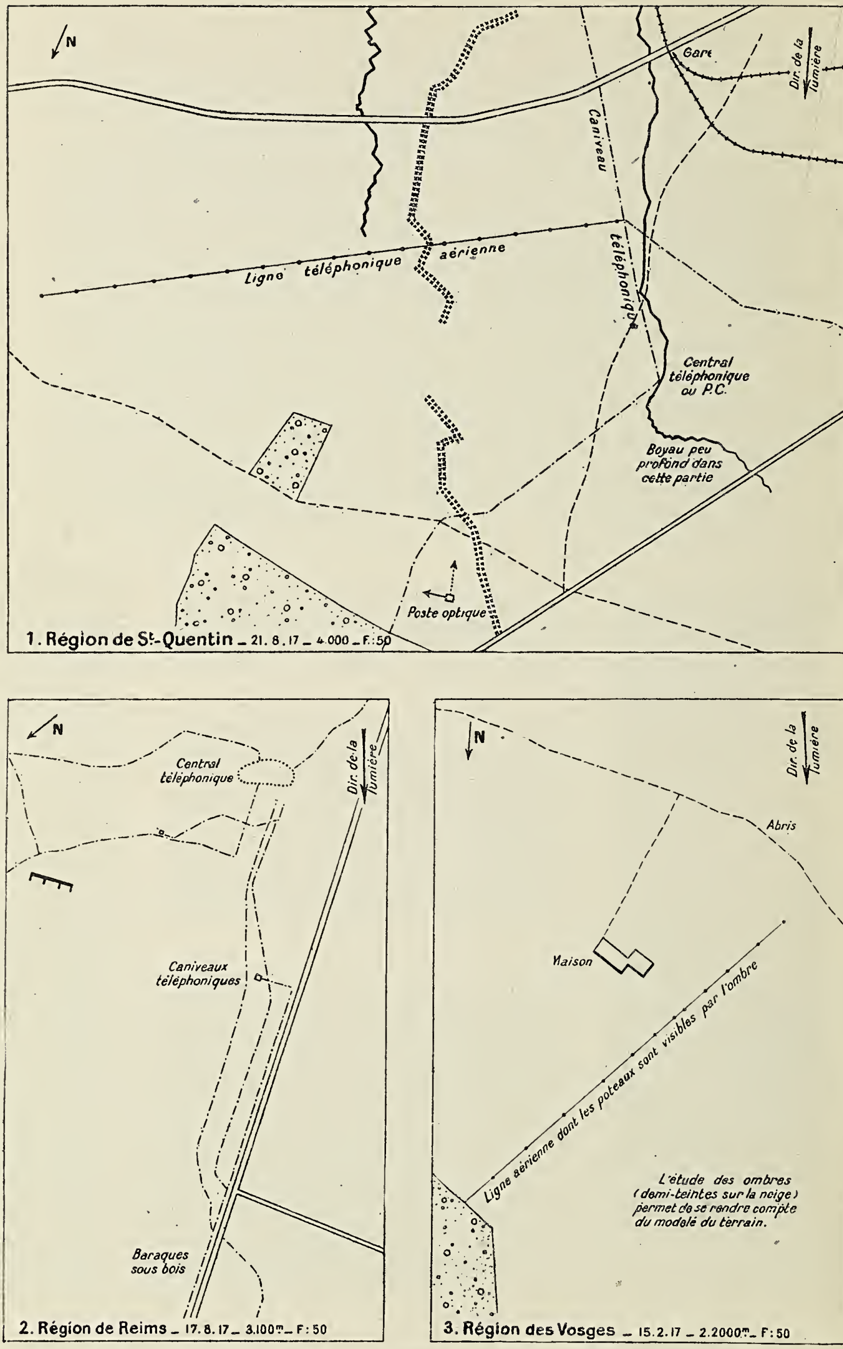
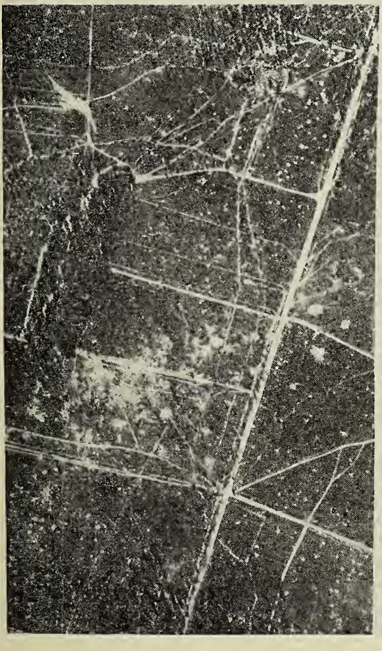


PLATE XXVI.—Telephone connections—Centrals.



1. Railroad station.—Aerial telephone line.—Telephone conduit.—Telephone central or H. Q.—Boyau shallower in this section.—Visual signal station.
2. Telephone central.—Telephone conduits.—Barracks in woods.
3. Shelters.—House.—Aerial wire, poles visible by their shadows.—Study of shadows (half-tone on snow) determines contour of ground.



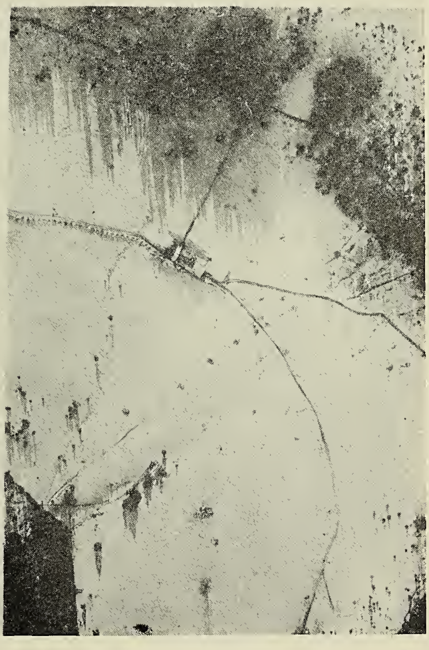
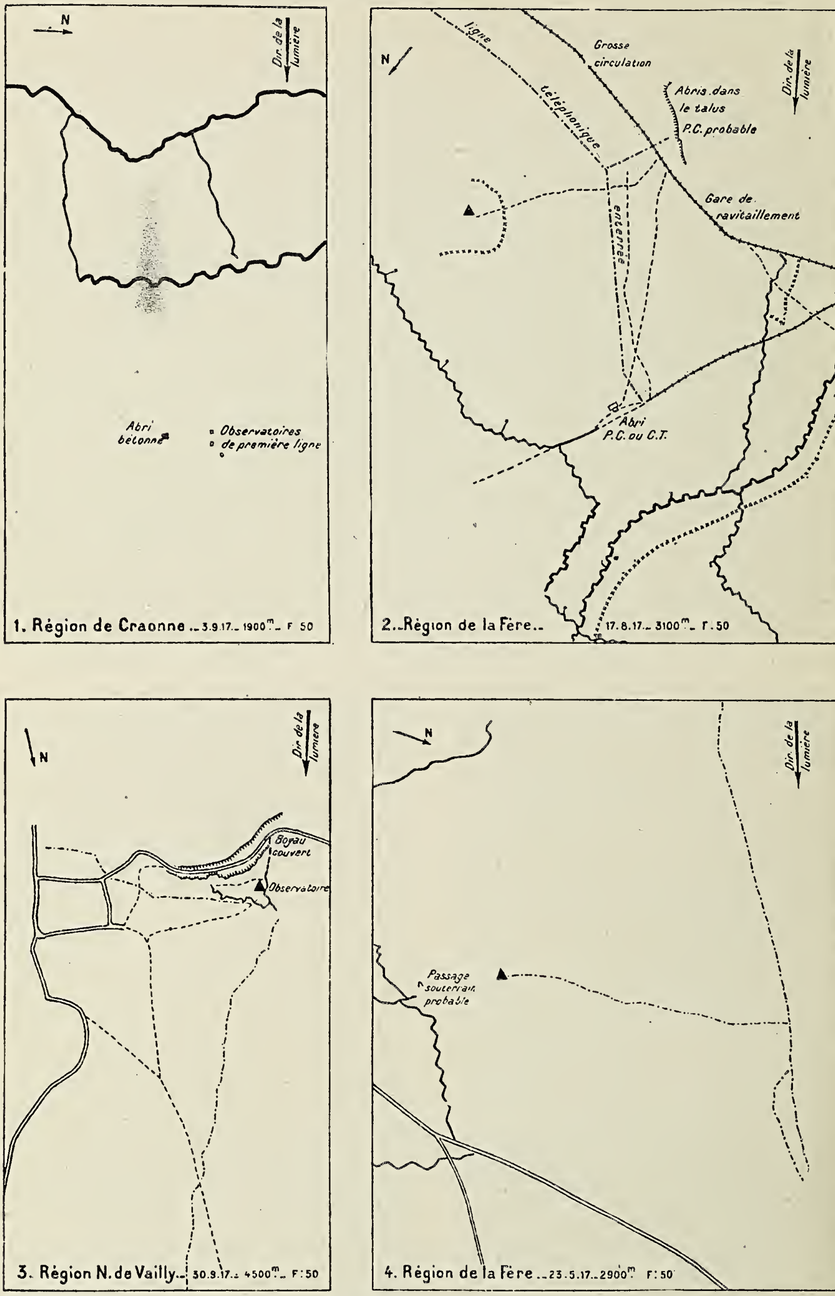


PLATE XXVII.—Headquarters' observation stations.



1. Concrete shelter.—Front line observation posts.
2. Buried telephone line.—Main road.—Shelters in bank. Probable H. Q.—Replenishing station.—Dugout for H. Q. or telephone central.
3. Covered trench.—Observation post.
4. Probable underground passage.

PLATE XXVII.

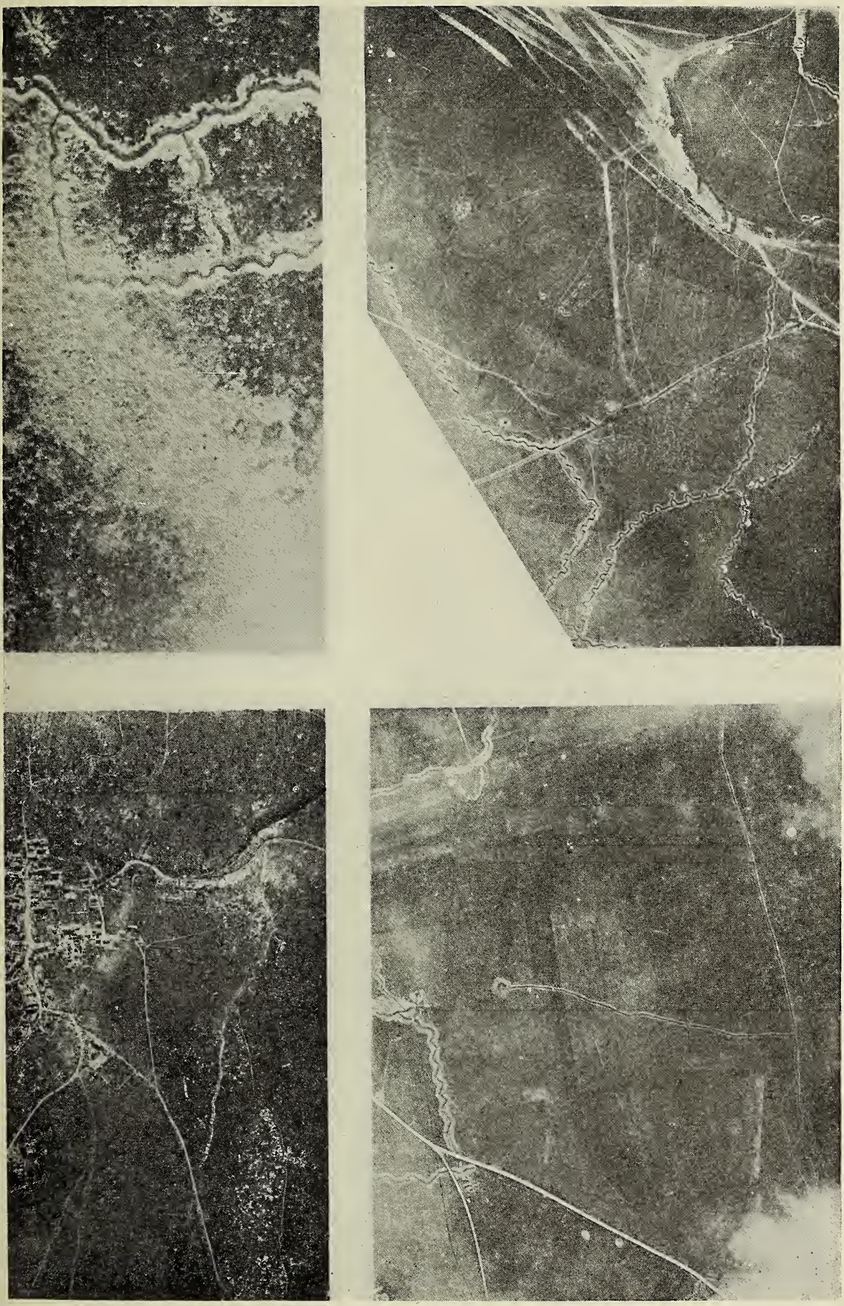
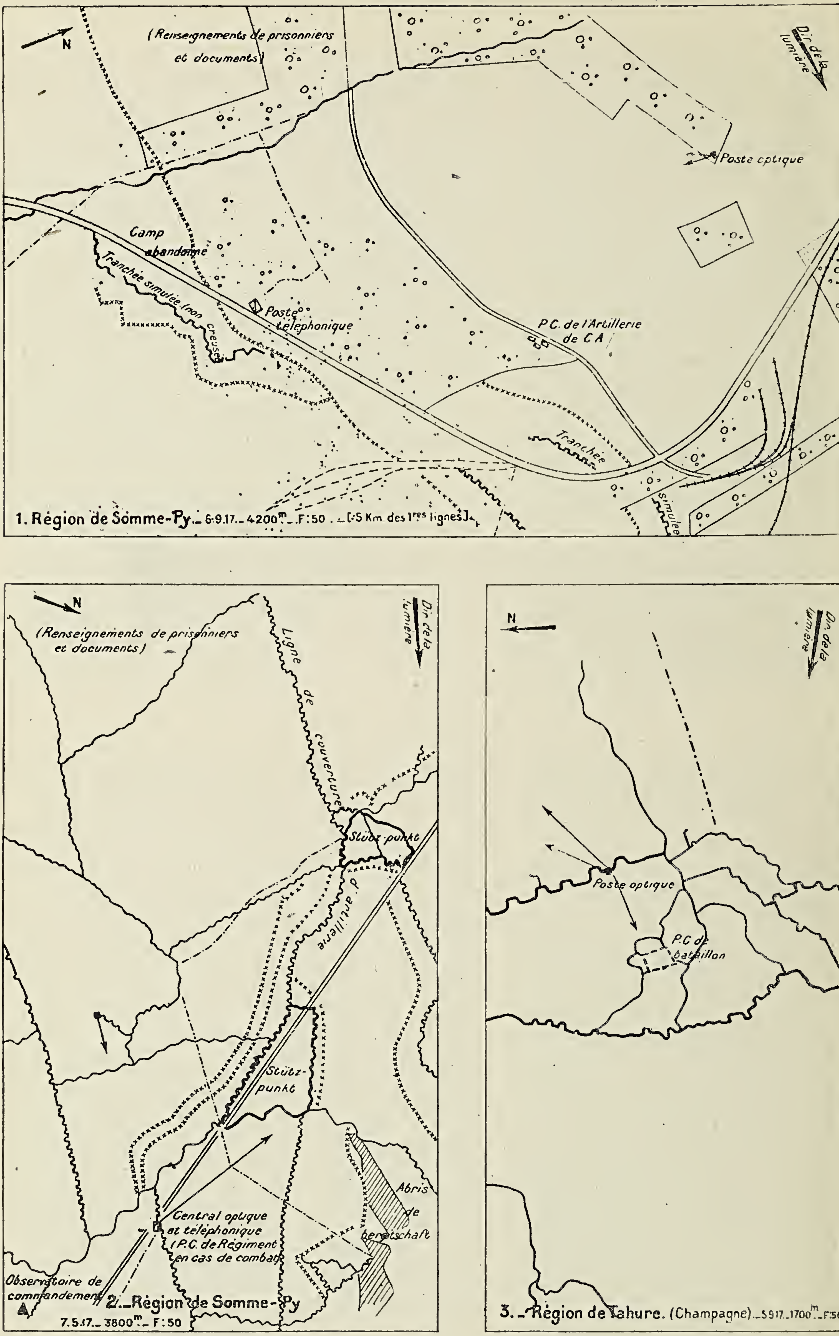


PLATE XXVIII.—Headquarters.



1. (Information from prisoners and documents).—Visual signal station.—Abandoned camp.—Imitation trench (not excavated).—Telephone station.—Headquarters of artillery of Army Corps.—Imitation trench.
2. Line covering artillery.—Supporting point.—Central visual and telephone station (regimental headquarters in case of battle).—Commander's observation station.—Shelters of reserves.
3. Visual signal station.—Battalion headquarters.

PLATE XXVIII.

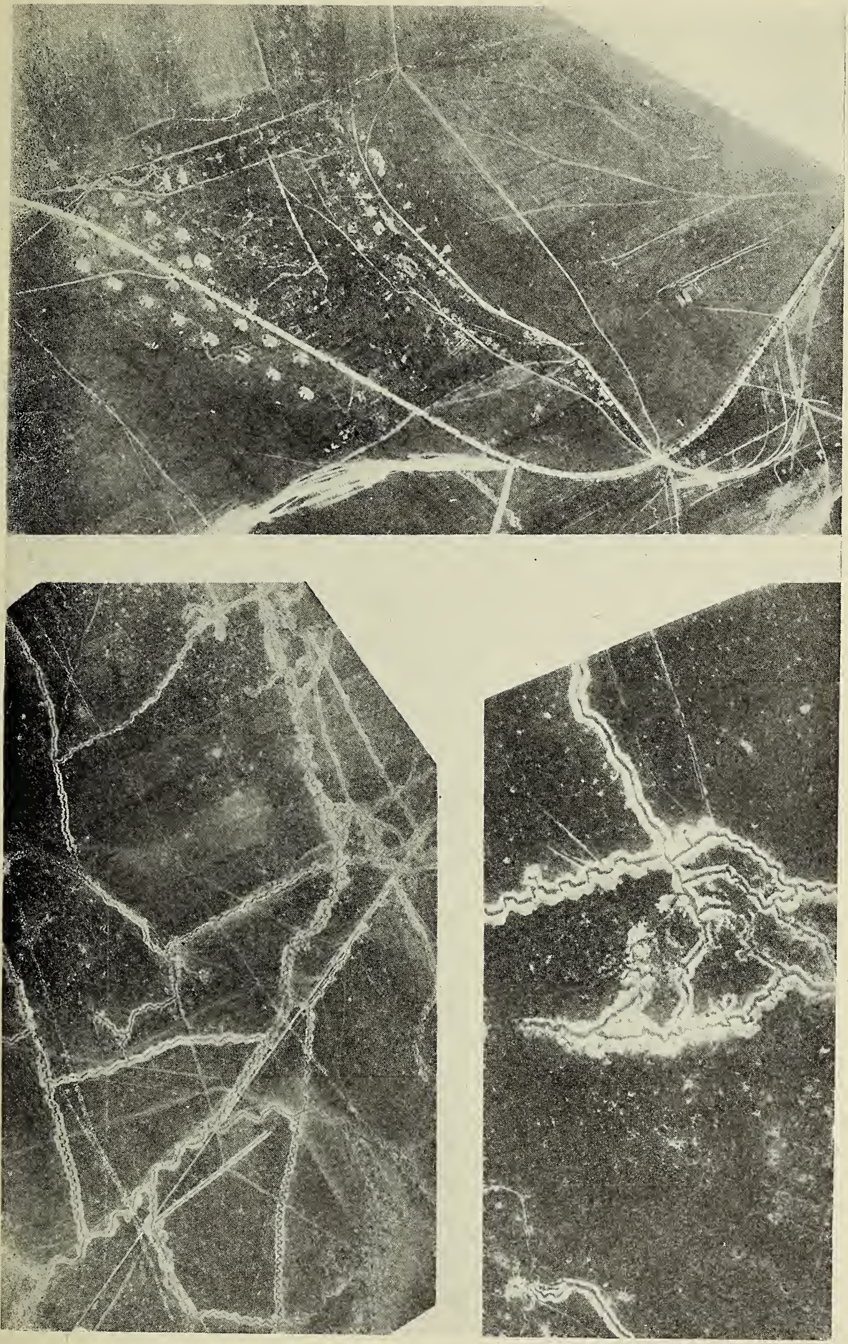
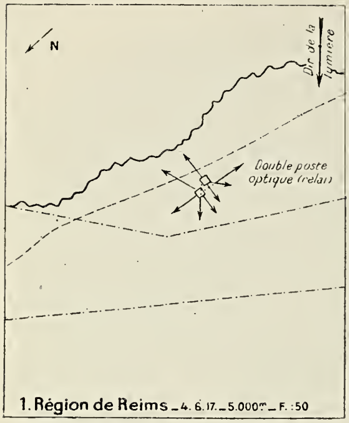
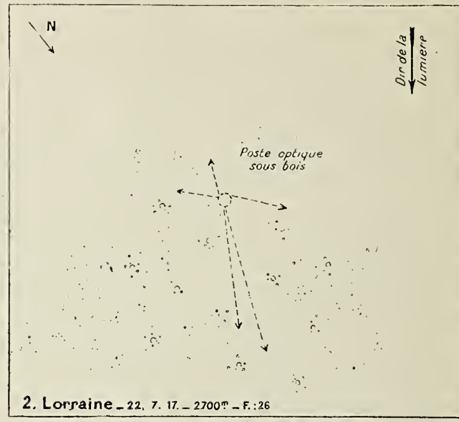
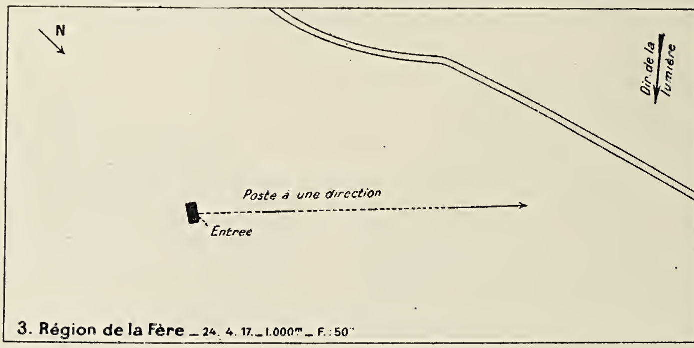
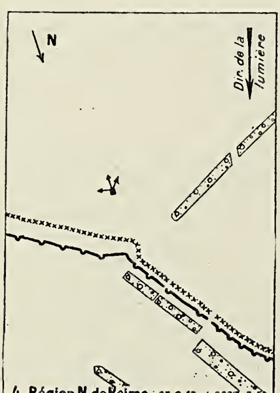


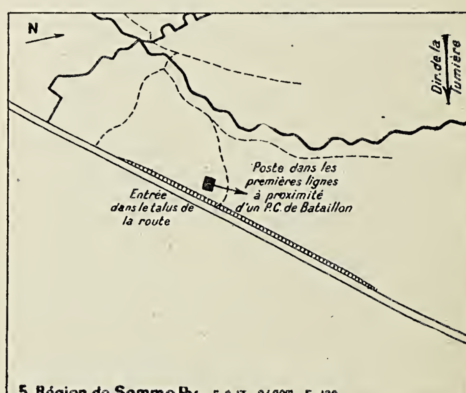
PLATE XXIX.—Visual signal stations.











1. Double visual signal station (relay).
2. Visual signal station in woods.
3. One direction signal station.—Entrance.
4. Signal station in front line near battalion headquarters.—Entrance in road bank.

PLATE XXIX.

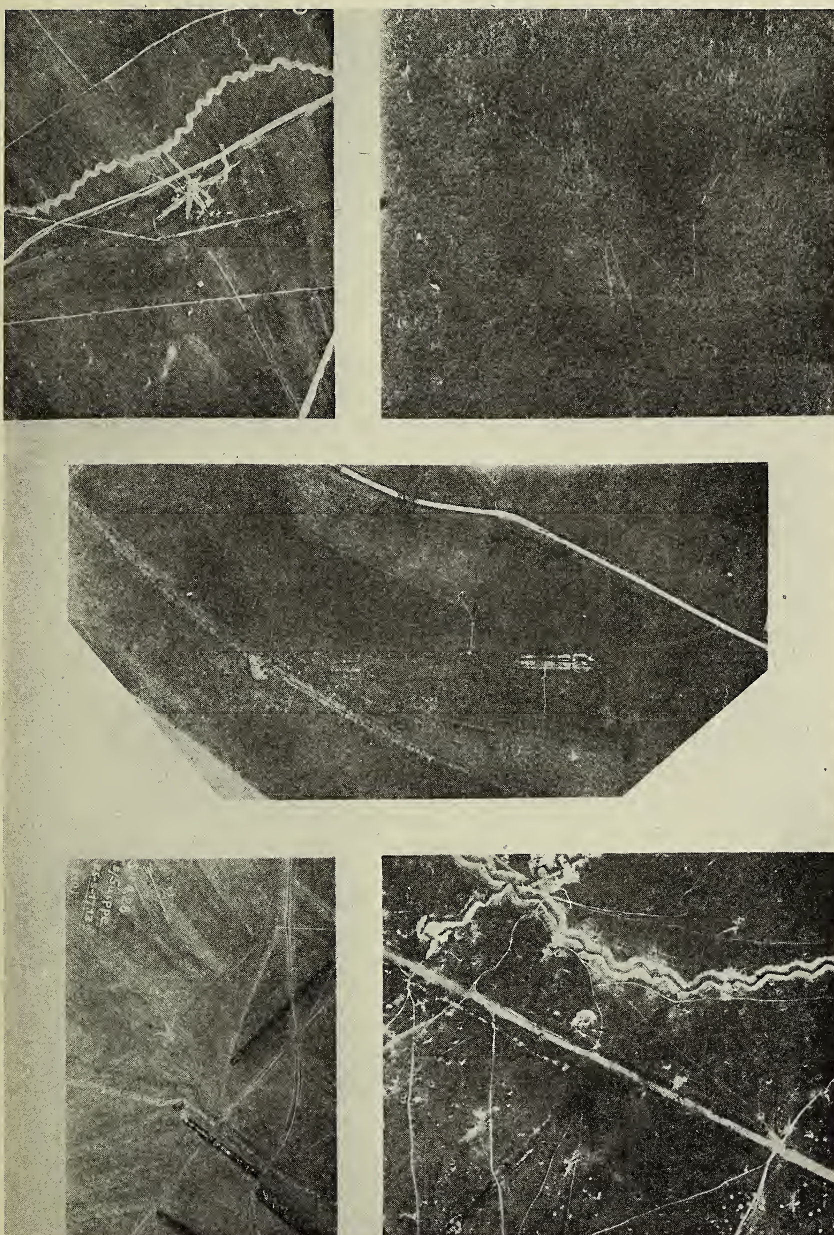
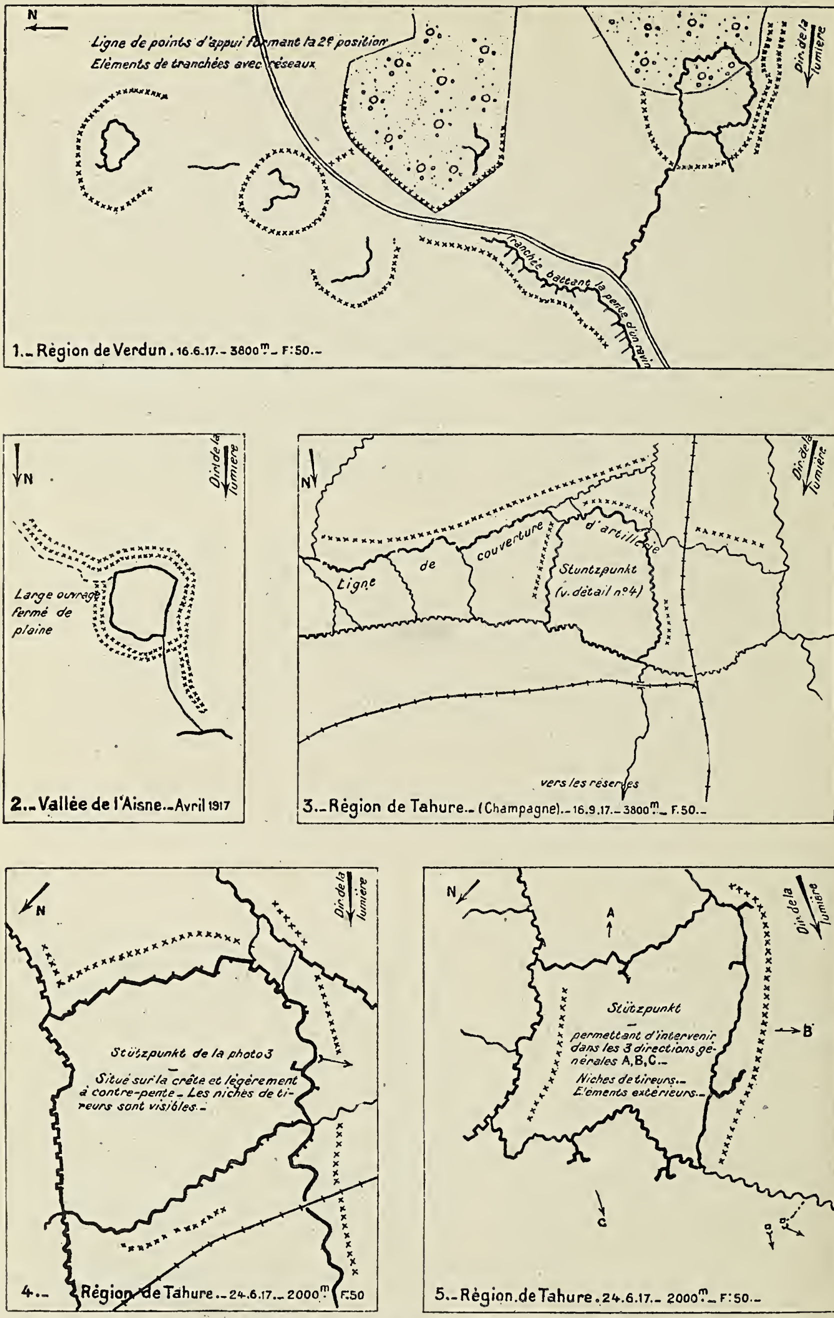


PLATE XXX.—Supporting points—Centers of resistance.



1. Points of support forming second line.—Trench elements with entanglements.—Trench along edge of ravine.
2. Wide works inclosing plain.
3. Line covering artillery.—Supporting position (see detail No. 4).—Toward reserves.
4. Supporting position of photo 3.—Located on crest and slightly on opposite slope. Sharpshooters' niches are visible.
5. Supporting position, enabling intervention in three general directions, A, B, C.—Sharpshooters' niches.—Outside elements.

PLATE XXX.

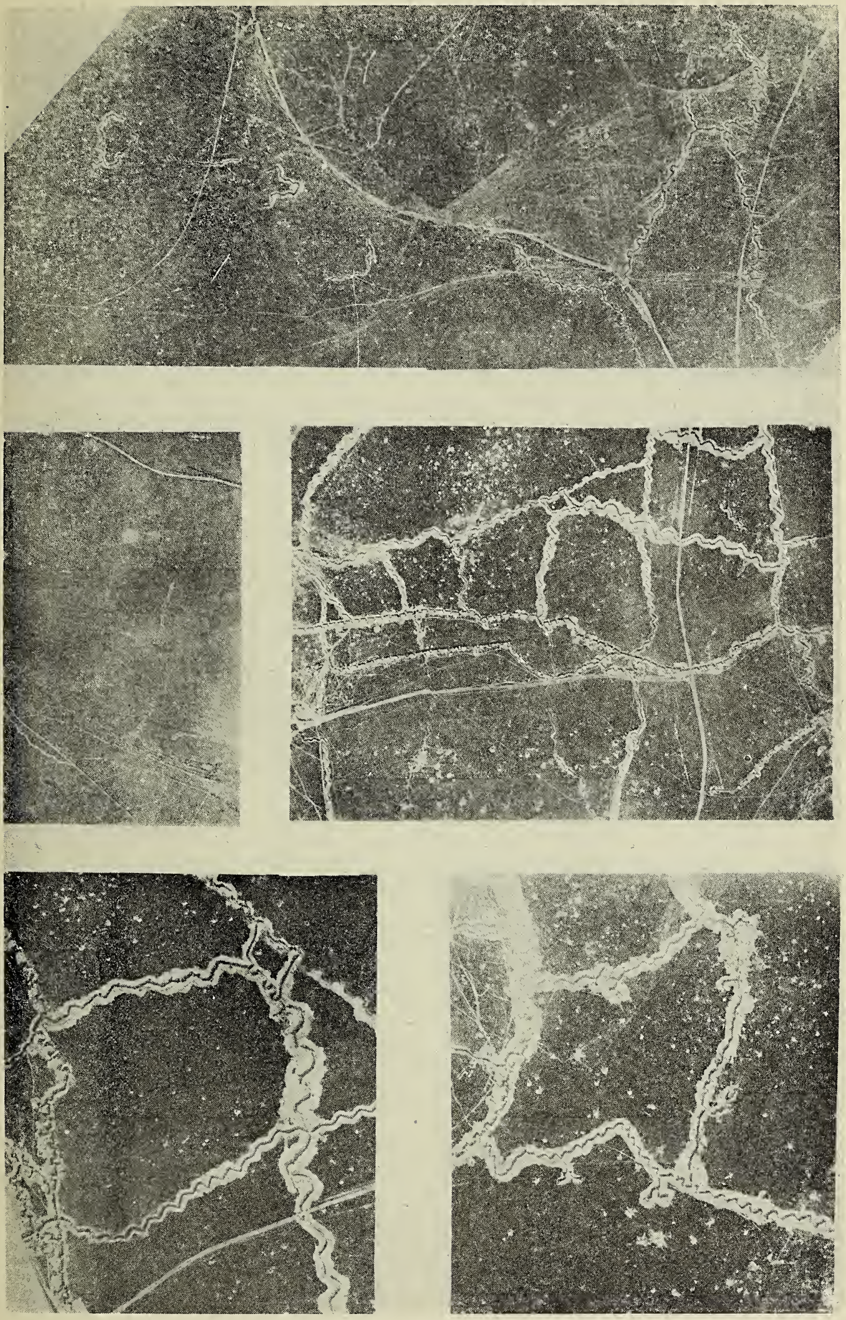
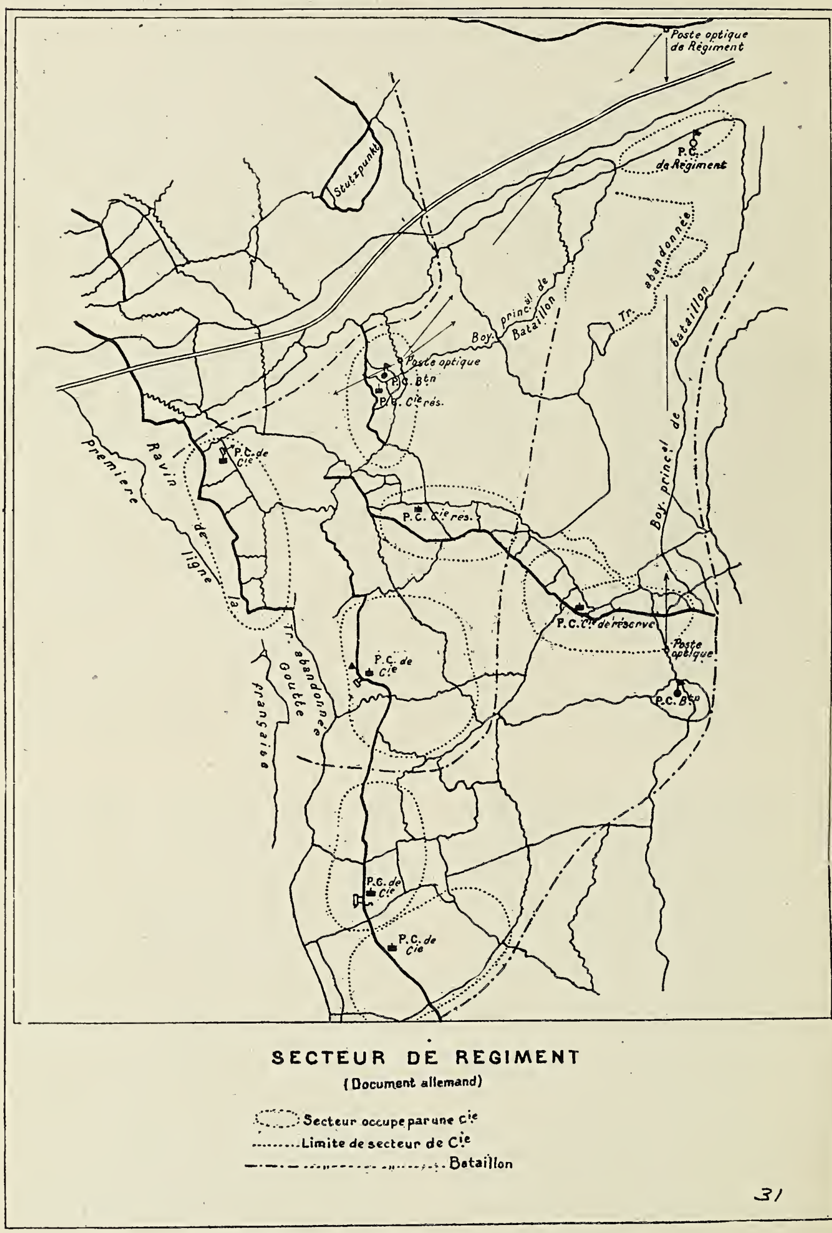


PLATE XXXI.—Organization of a regimental sector.



REGIMENTAL SECTOR (German document).

Sector occupied by a company.
Limits of company sector.
Limits of battalion sector.

PLATE XXXI.

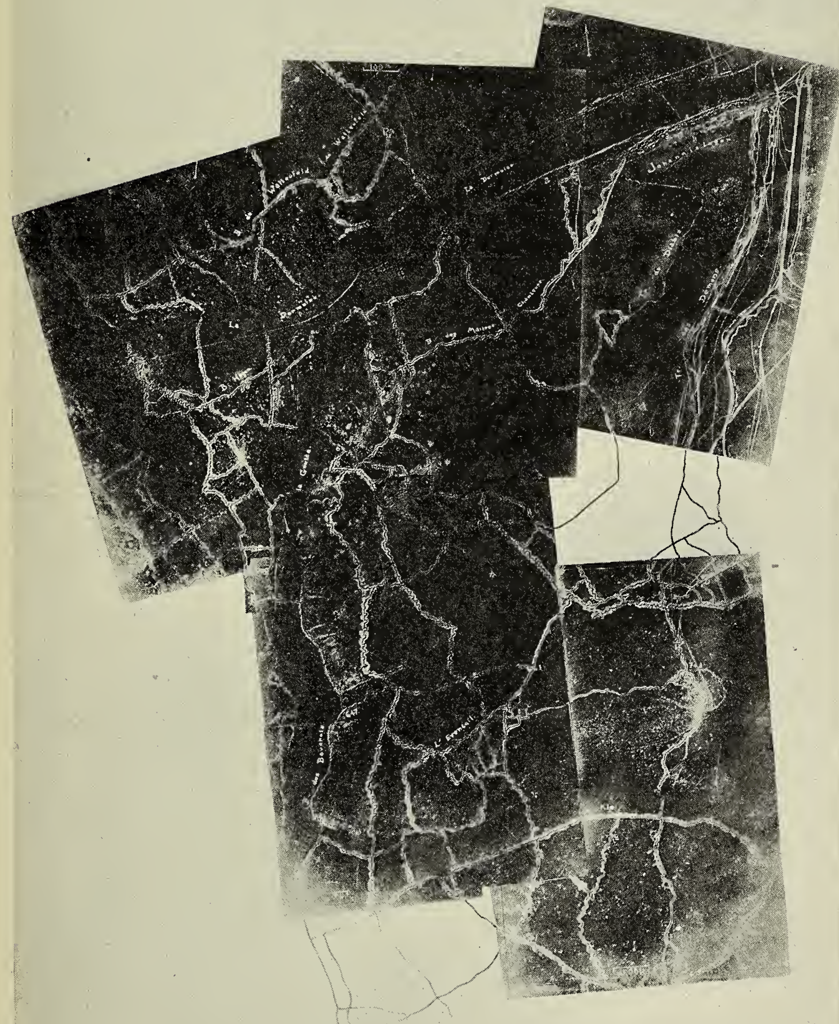
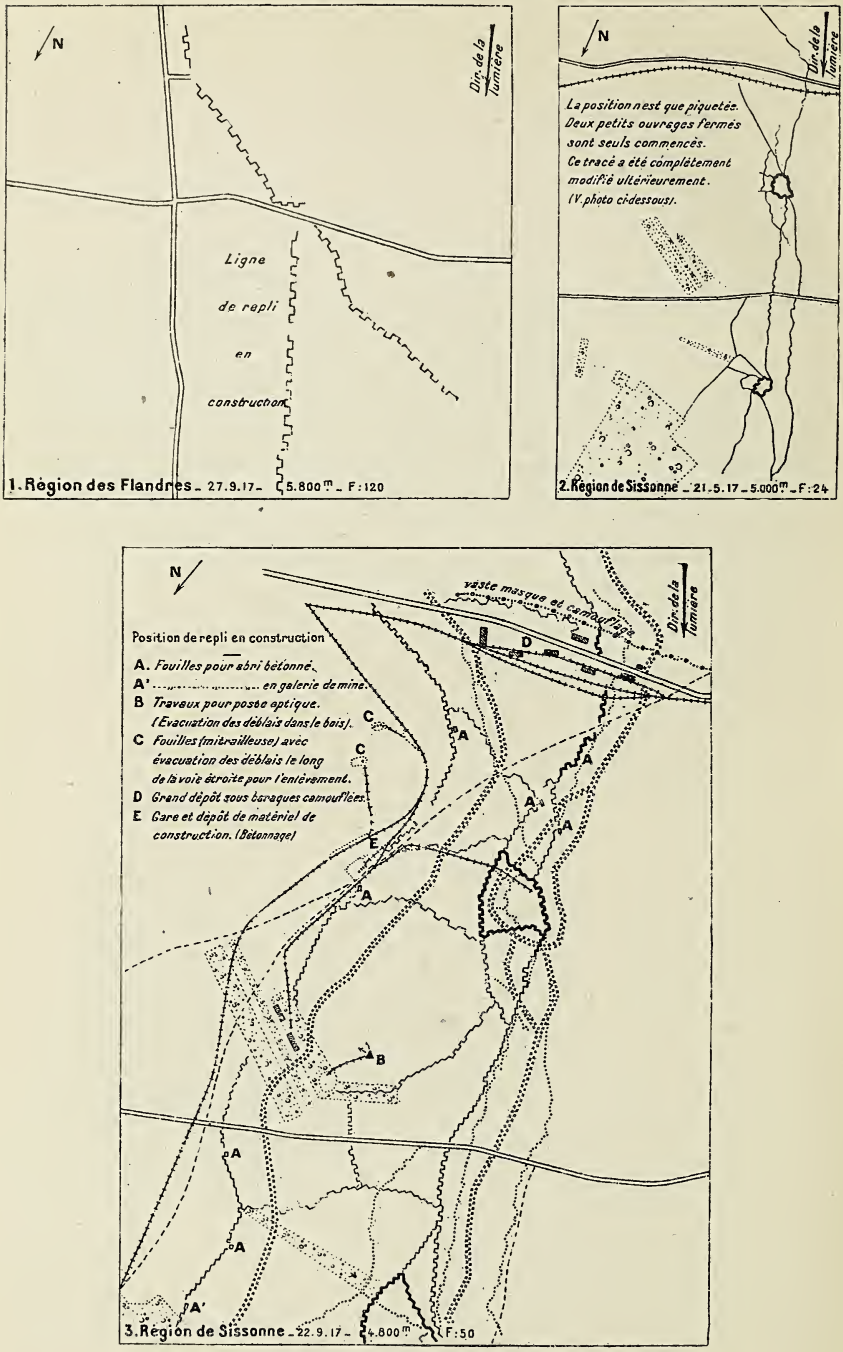


PLATE XXXII.—Lines of support (1) Flanders, Sissonne.



LINES FOR FALLING BACK—FLANDERS, SISSONNE.

1. Line for falling back under construction.
2. Lines are only traced. Two small inclosed defenses are the only ones begun. This tracing was completely changed later. (See photo below.)
3. Falling-back line under construction.—A. Excavations for concrete shelters.—A′. Excavations for underground dugouts.—B. Fortifications for visual station (removal of dirt to woods).—C. Excavations (machine gun) with deposit of dirt along narrow-gauge railway for removal.—D. Grand depot under camouflaged barracks.—E. Station and depot of construction material (concrete).

PLATE XXXII.

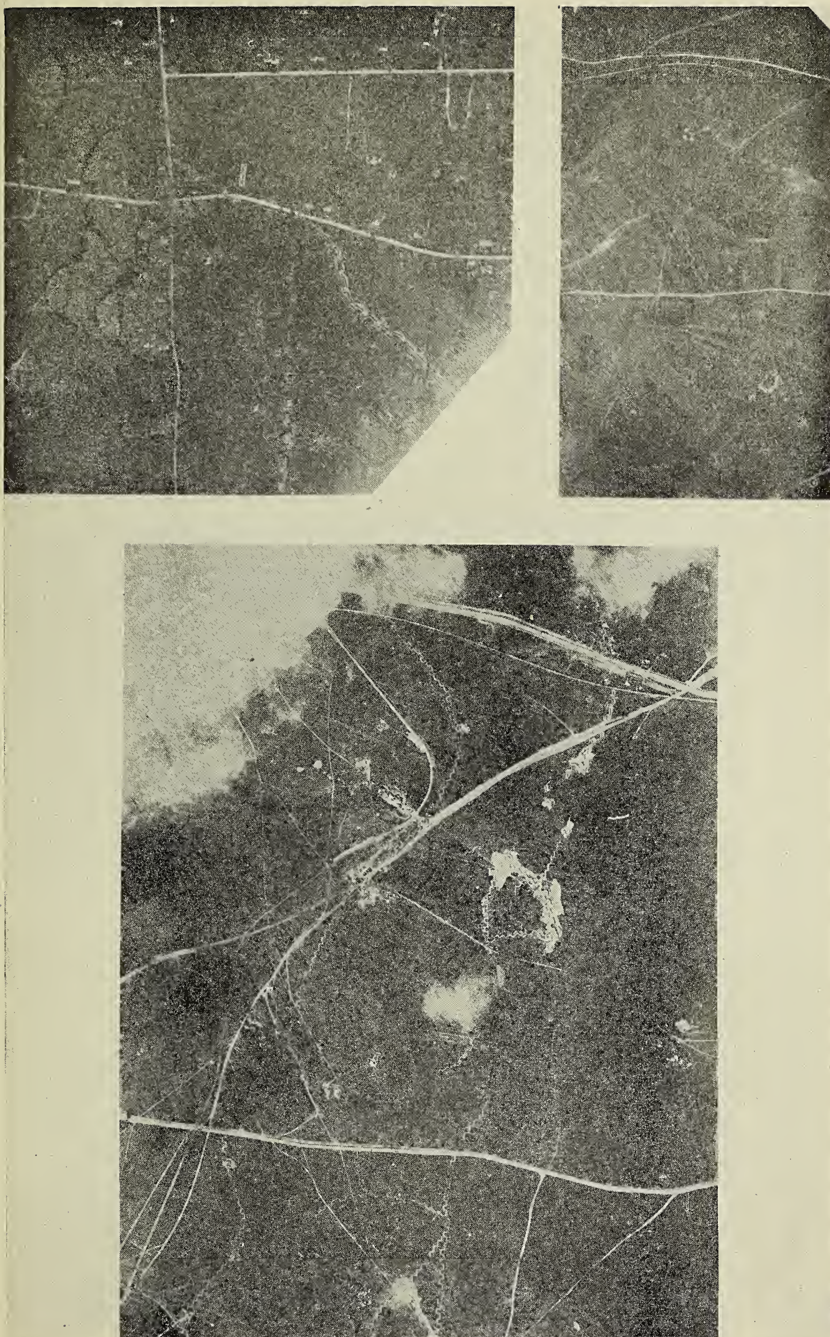
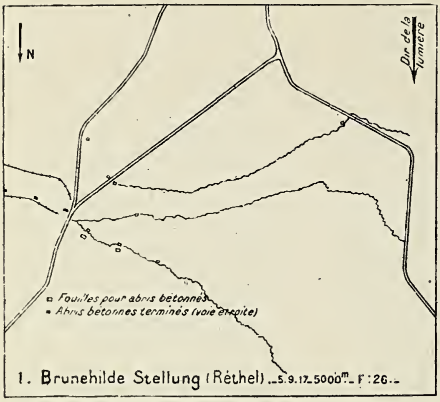
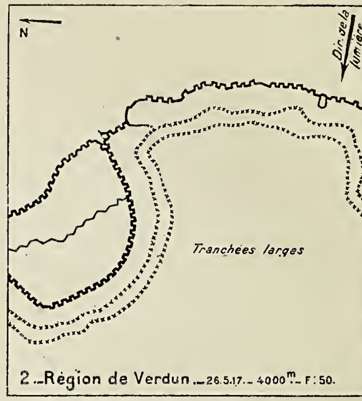


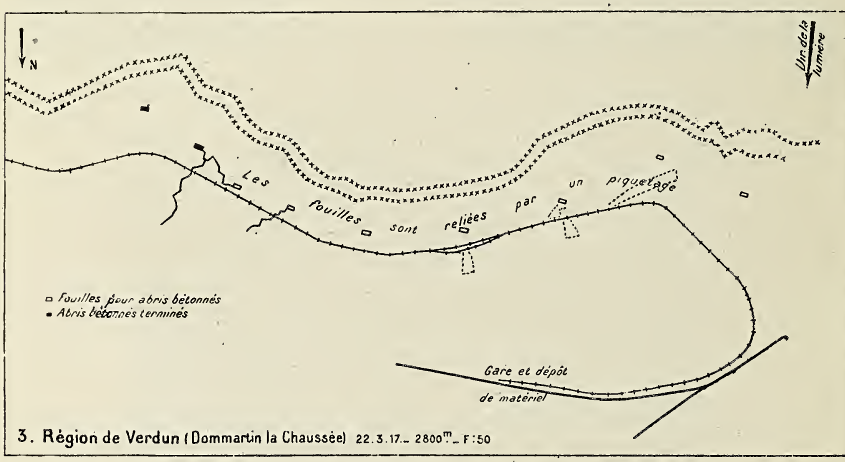
PLATE XXXIII.—Lines of support (2) Aisne, Verdun, Alsace.



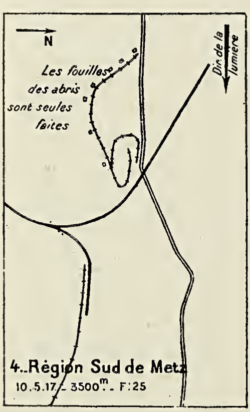
1. Brunehilde Stellung (Réthel) _5.9.17_5000m_ F:26._



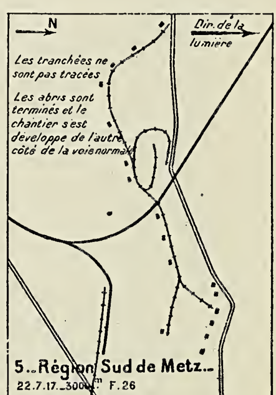
2._Région de Verdun _26.5.17._ 4000m_ F:50.



3. Région de Verdun (Dommartin la Chaussée) 22.3.17._ 2800m_ F:50



4._Région Sud de Metz
10.5.17._ 3500m_ F:25



5._Région Sud de Metz._
22.7.17._3000m F.26

1. Brunhilde position.—Excavations for concrete shelters.—Finished concrete shelters (narrow-gauge railway).
2. Wide trenches.
3. Excavations are connected by a tracing.—Excavations for concrete shelters.—Station and supply depot.

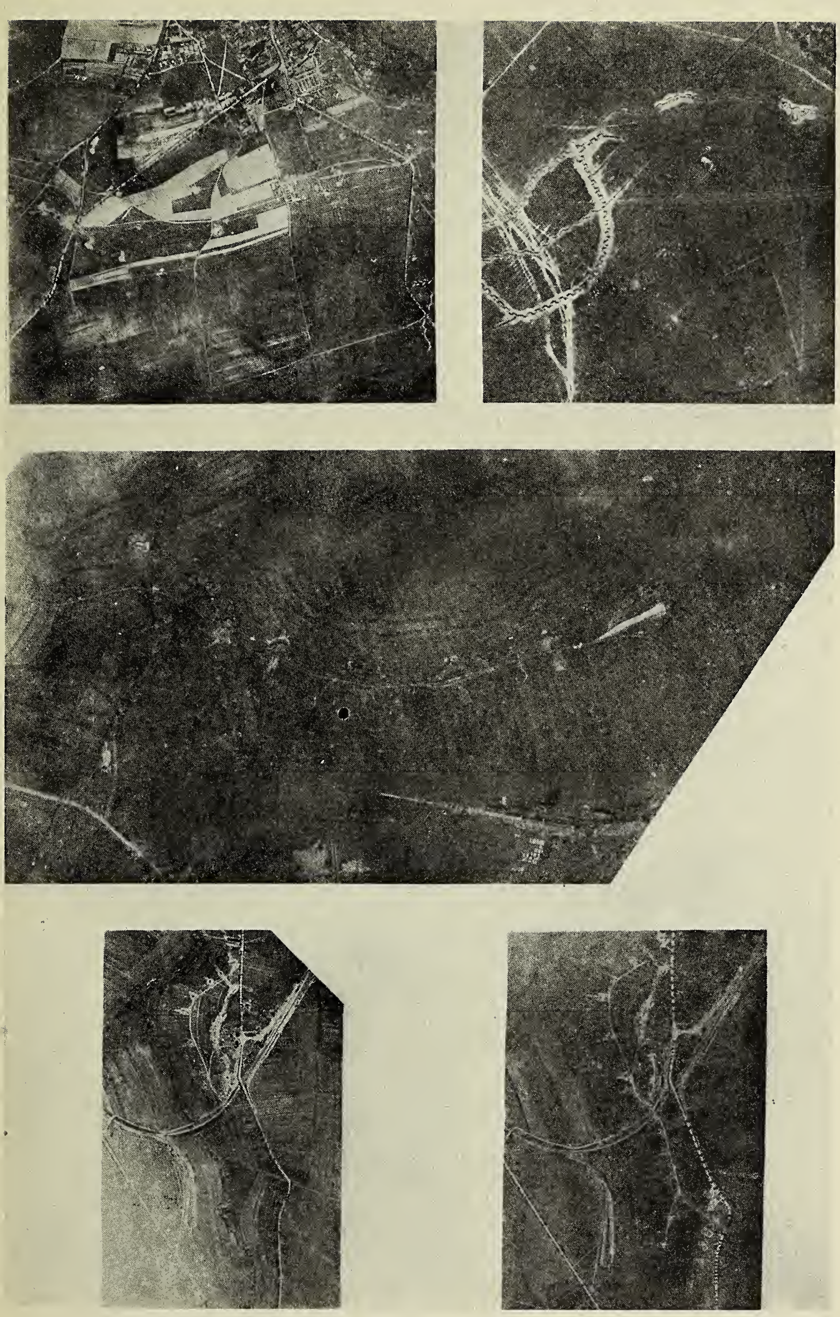
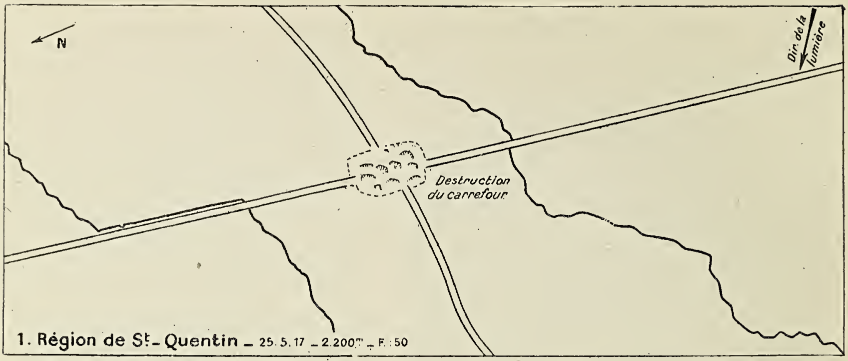
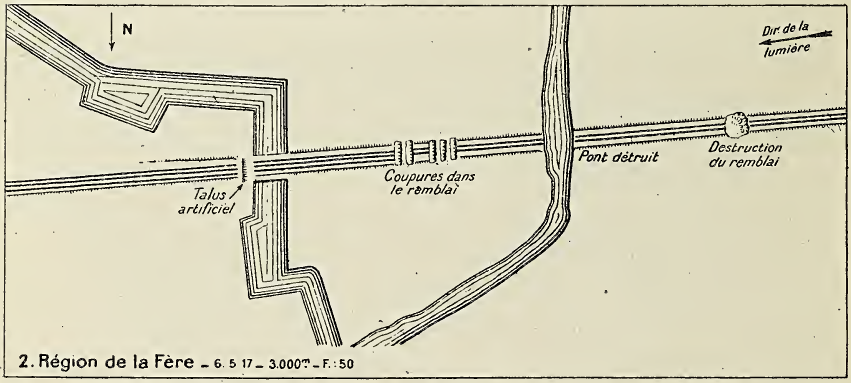
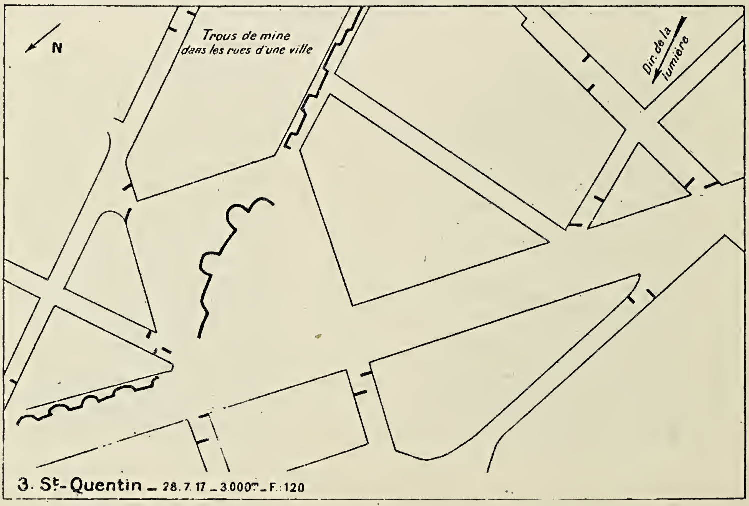


PLATE XXXIV.—Demolitions before retreat.







1. Demolition of crossroads.
2. Artificial bank.—Cuts in the banking.—Destroyed bridge.—Demolition of bank.
3. Shell holes in village street.

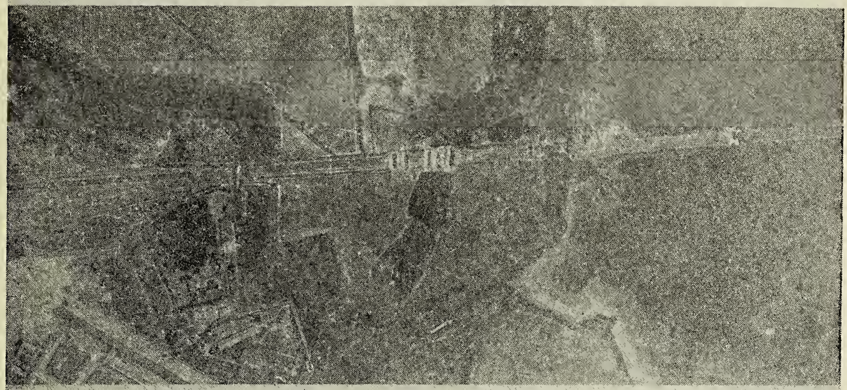
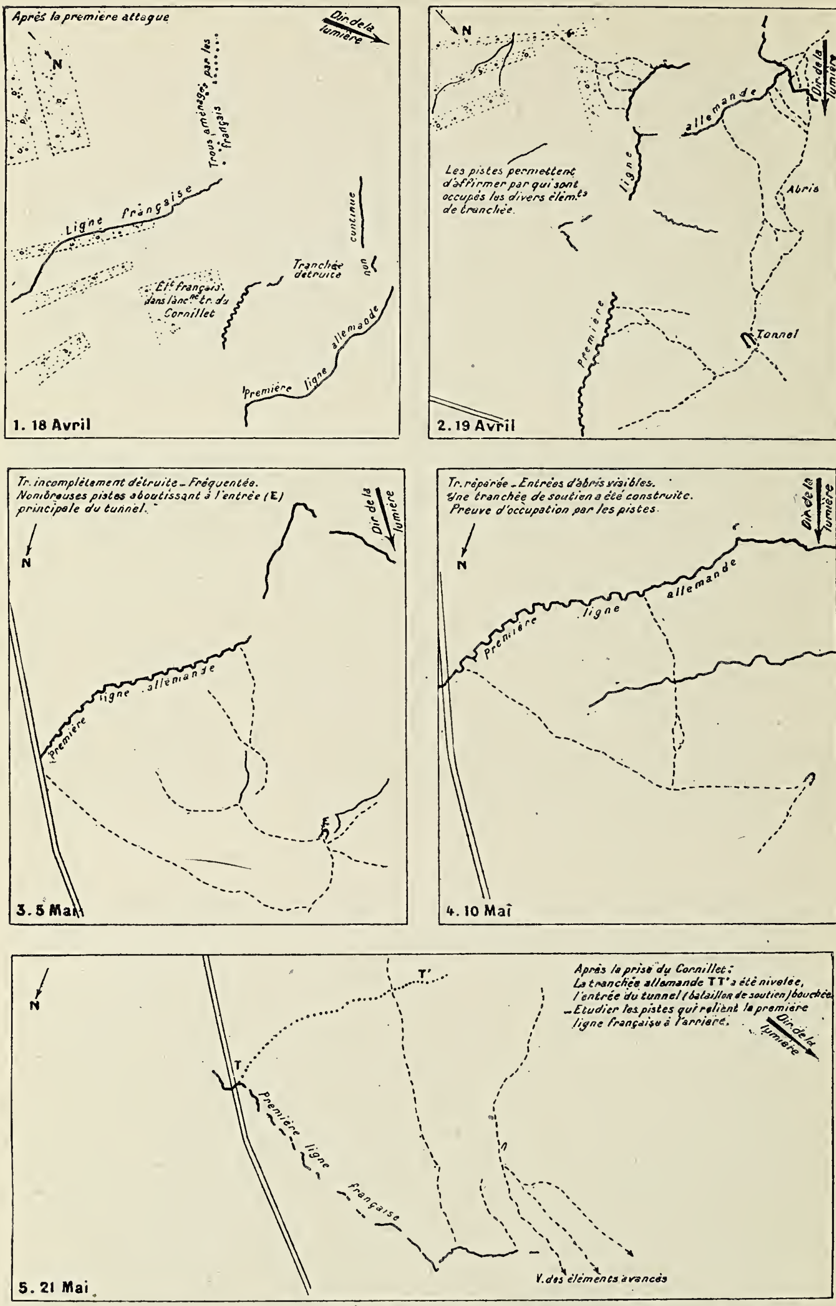


PLATE XXXV.—Photos during battle (1).

PRISE DU CORNILLET (Avril–Mai 1917)



1. After the first attack.—Holes altered by the French.—French line.—Part of French trench in the old trench of Cornillet.—Destroyed trench.—German front line not continuous.
2. Paths show which trench elements are occupied.—German front line.
3. Partly destroyed trench, in use. Numerous paths terminate at principal entrance of tunnel.—German front line.
4. Repaired trench. Dugout entrances visible. A supporting trench has been constructed. Occupation shown by paths.—German front line.
5. After capture of Cornillet.—German trench T T′ was leveled. Tunnel entrance (supporting battalion) closed up.—Study paths connecting French front line with the rear.—French front line.—Toward advanced elements.

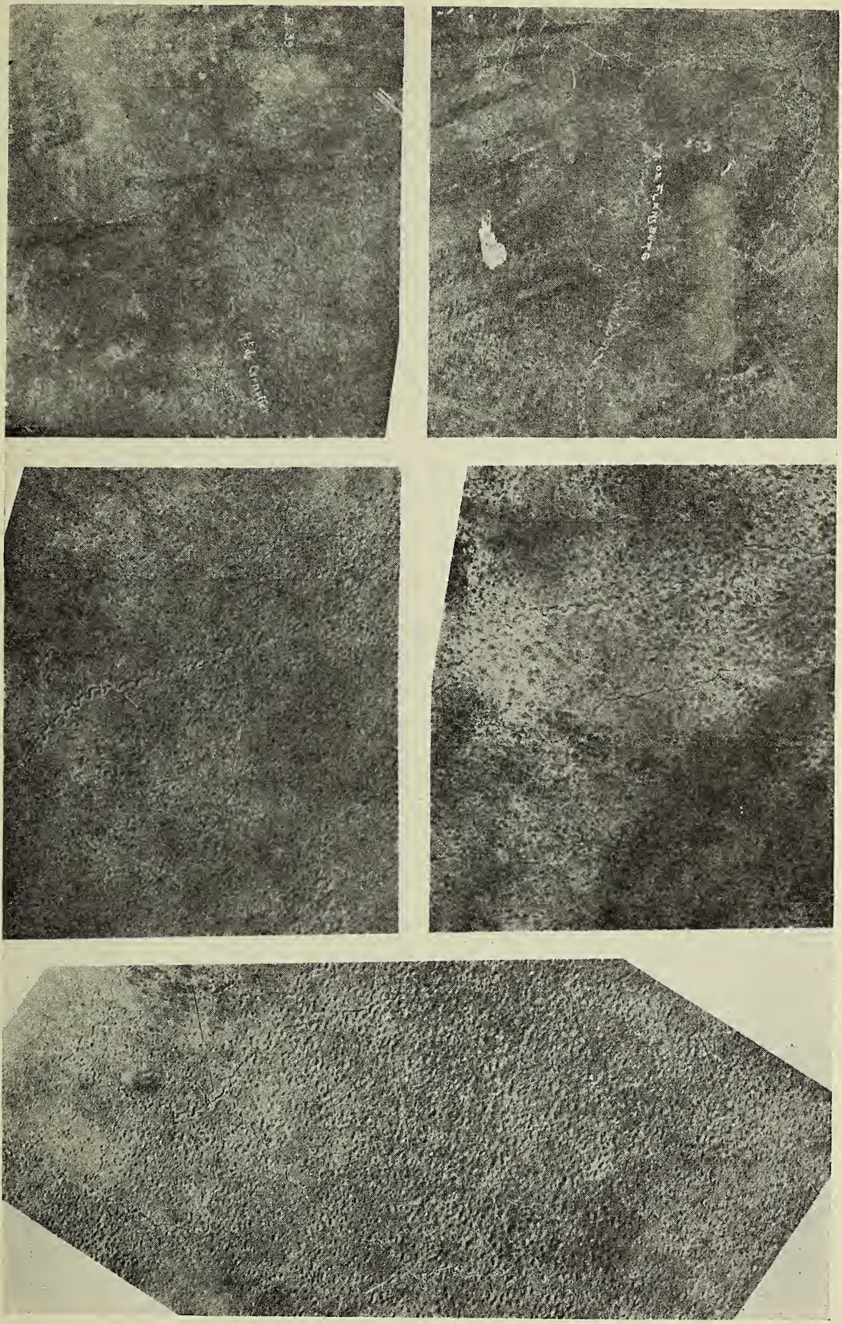
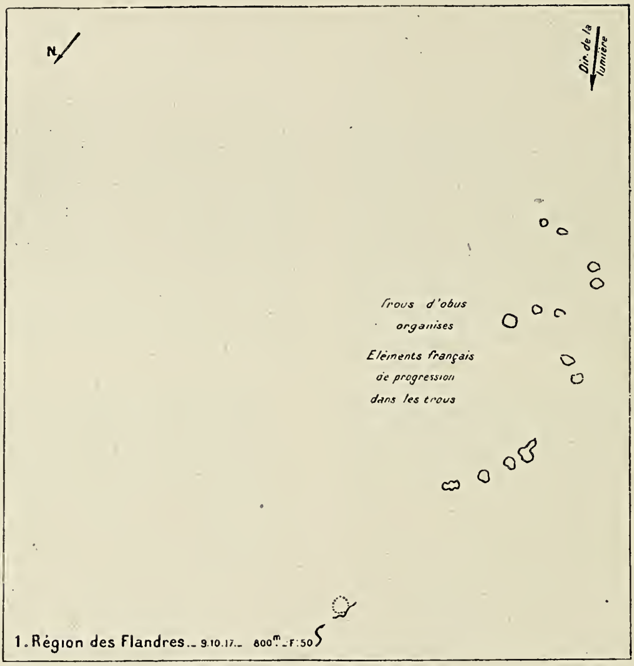
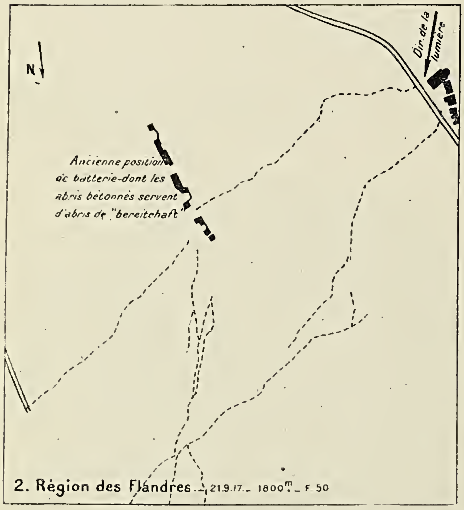
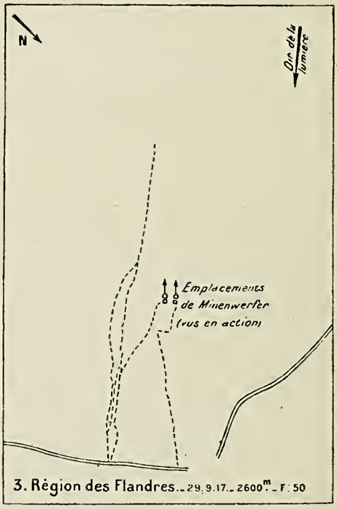


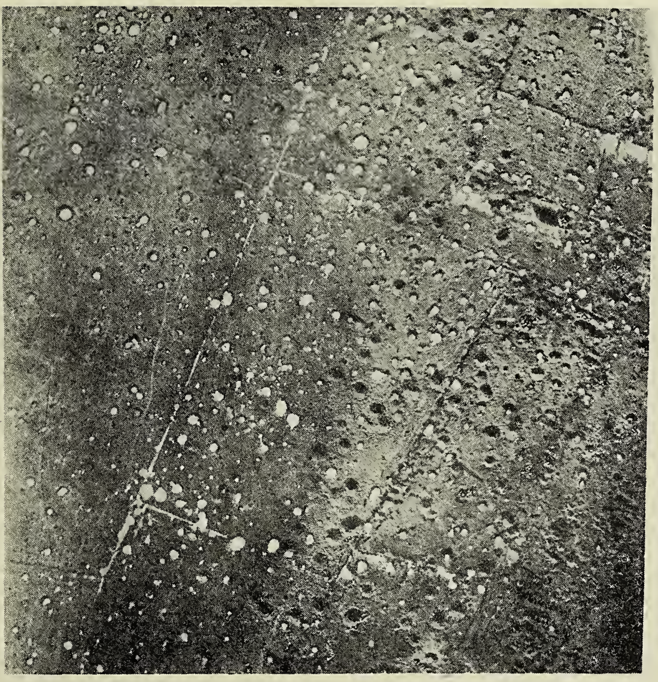
PLATE XXXVI.—Photos during battle (2) reserves, mines.







1. Organized shell holes.—Advancing French elements in the holes.
2. Old position of battery, including concrete dugouts serving to shelter reserves.
3. Emplacements of trench mortars (seen in action).



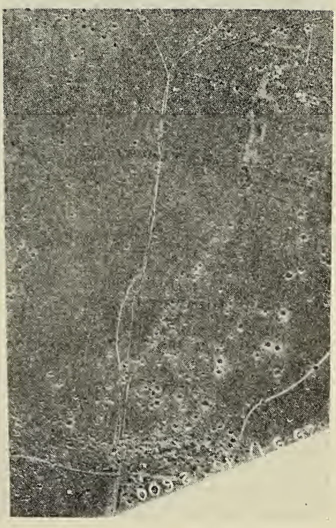
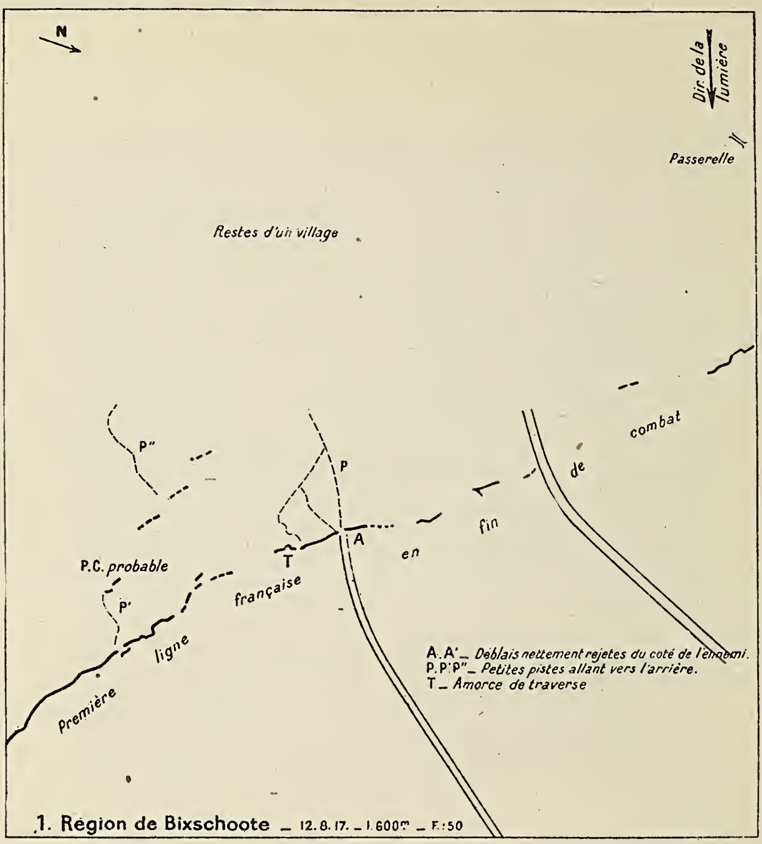
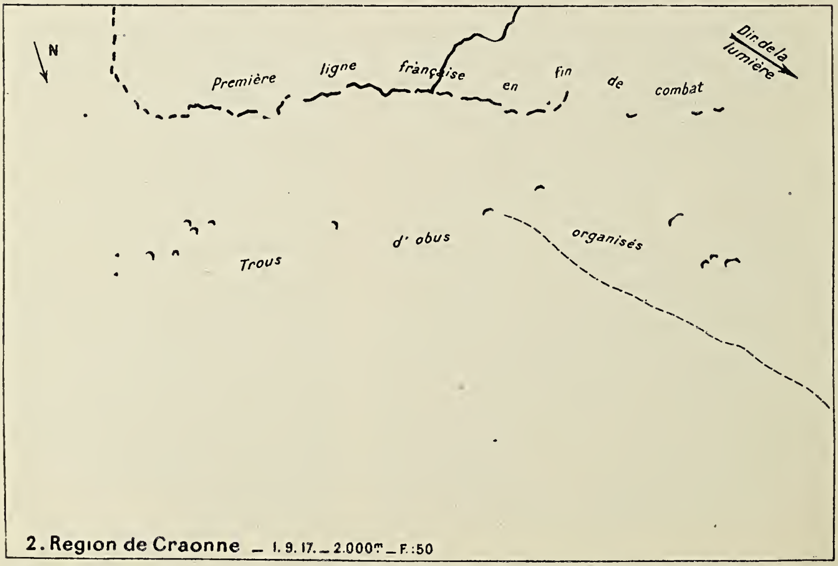


PLATE XXXVII.—Lines after battle (1) vertical and oblique views.





1. Footbridge.—Remains of village.—Probable headquarters.—French front line at end of battle.—A. A., Excavated earth thrown out on side toward enemy.—P. P.′ P.″ Narrow paths leading to rear.—T. Beginning of traverse.
2. French front line at end of battle.—Organized shell holes.

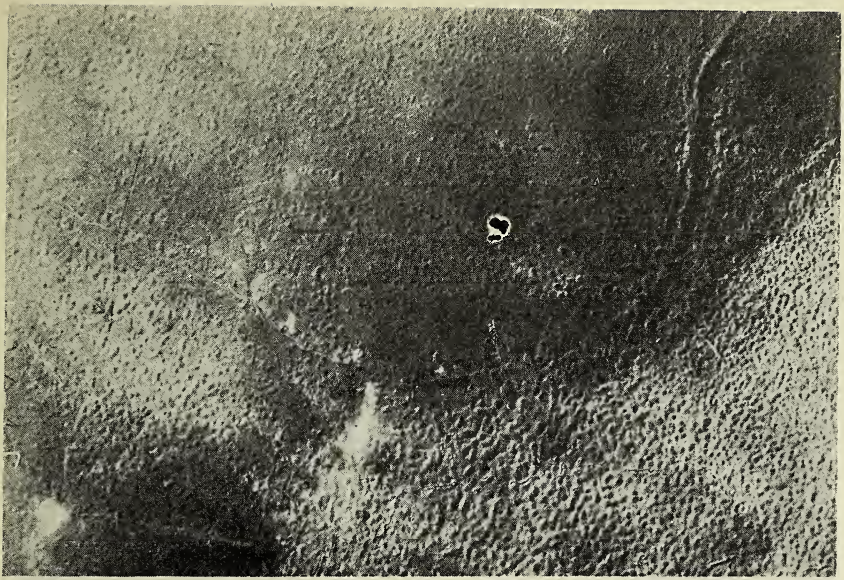
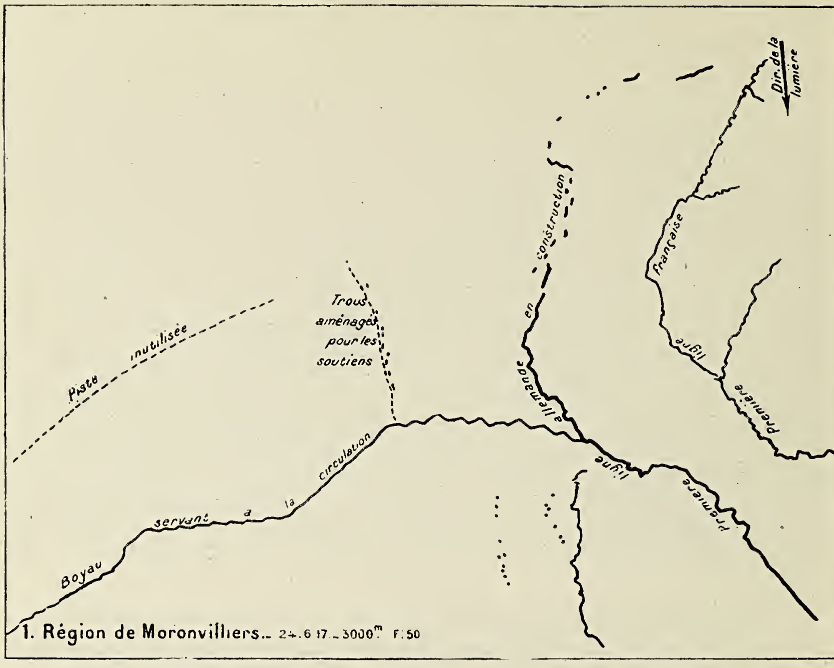
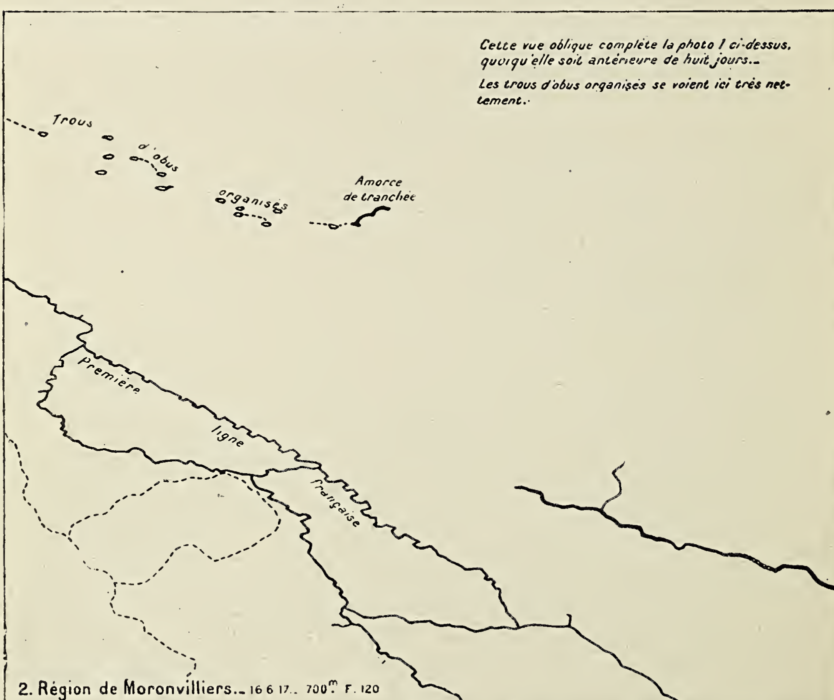
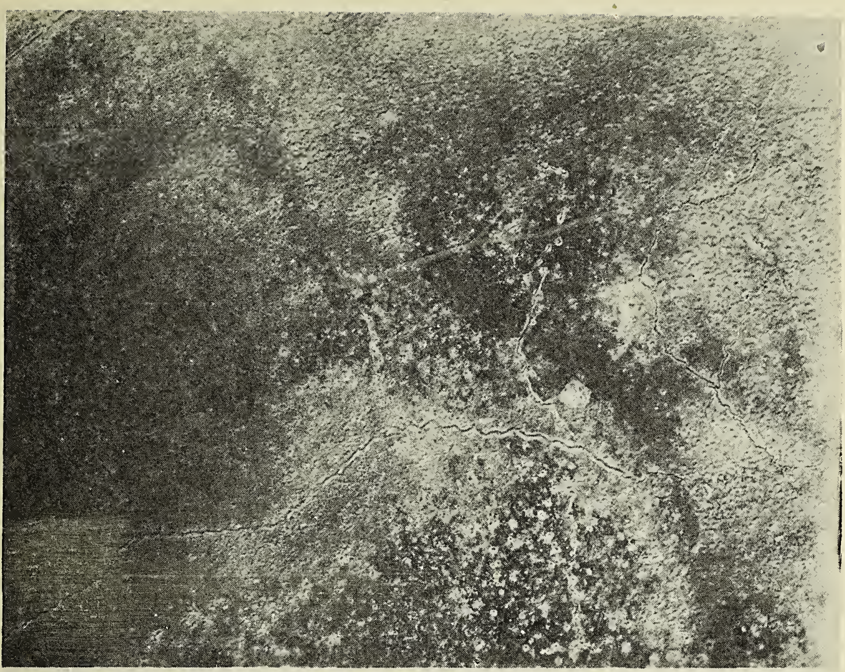


PLATE XXXVIII.—Lines after battle (2).





1. Unused trail.—Holes prepared for reserves.—Boyau for circulation.—German front line under construction.—French front line.
2. This oblique completes photo 1, although it was taken a week earlier. The organized shell holes show plainly.—Organized shell holes.—Trench fragment.—French front line.



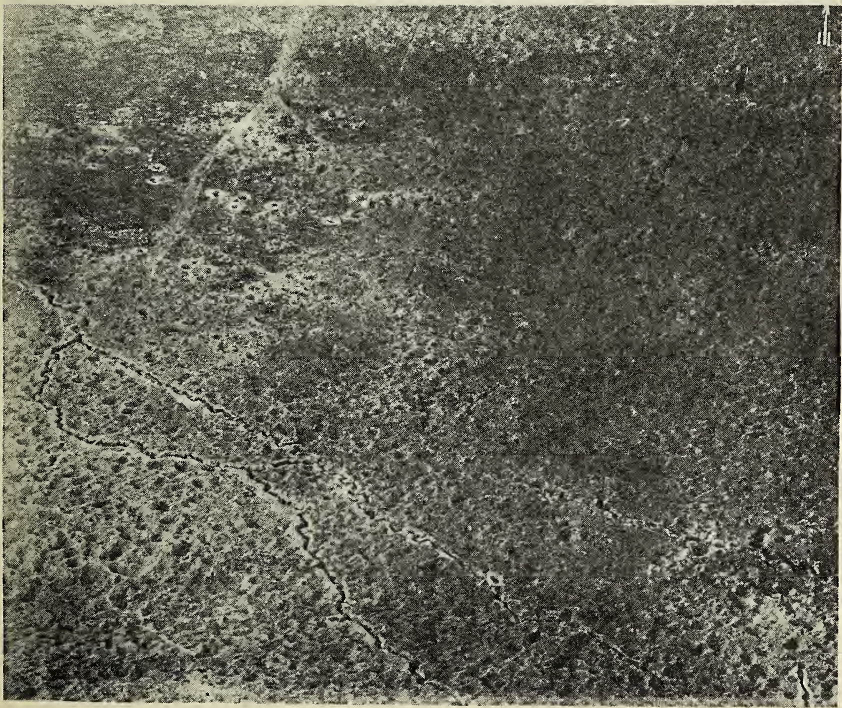
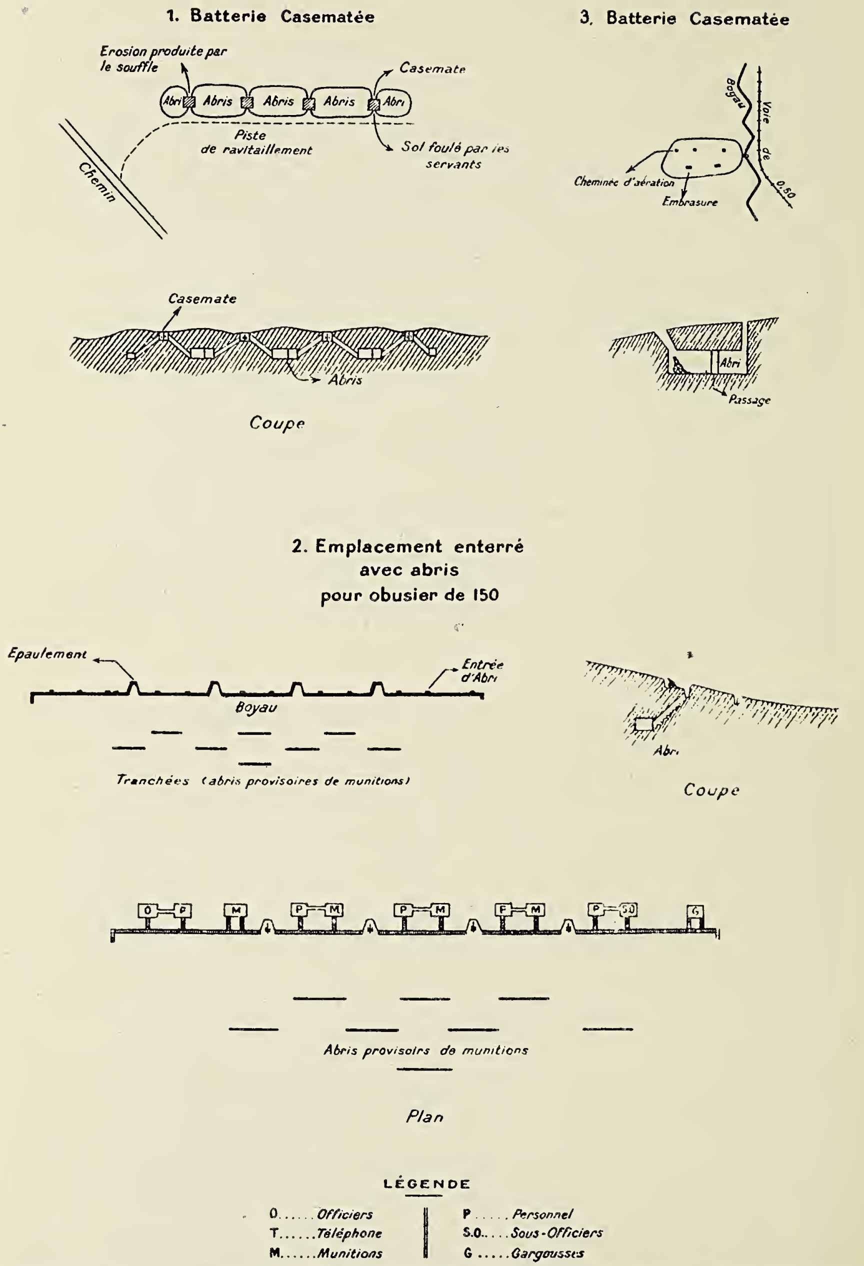


PLATE XXXIX.—Battery types—Sketches.

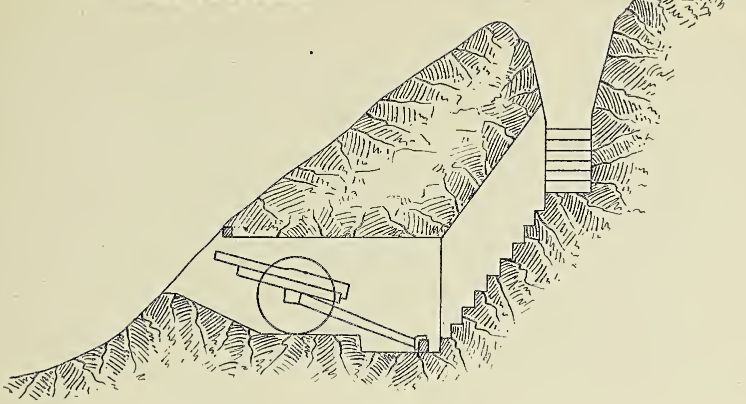


1. Casemated battery.—Erosion produced by blast.—Road.—Replenishing road.—Earth trampled by gunners.—Dugout.
2. Sunken emplacement, with dugout, for 150 mm. howitzer.—Breastwork.—Trench.—Dugout entrance.—Trenches.—Provisional munition dugouts.
3. Casemated battery.—Boyau.—0.6 m. railway.—Airshaft.—Embrasure.—Dugout.

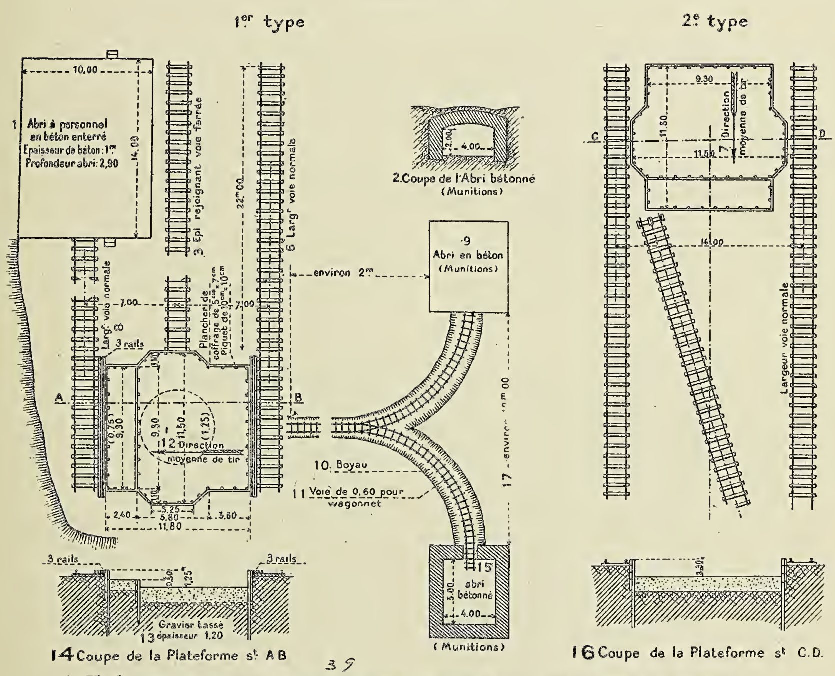
LEGEND.

O. Officers.—T. Telephone.—M. Munitions.—P. Personnel.—S. O. Noncoms.—G. Cartridges.

4. Batterie dans un talus
orienté vers l'ennemi



5. Plateformes de 240 M. Allemand



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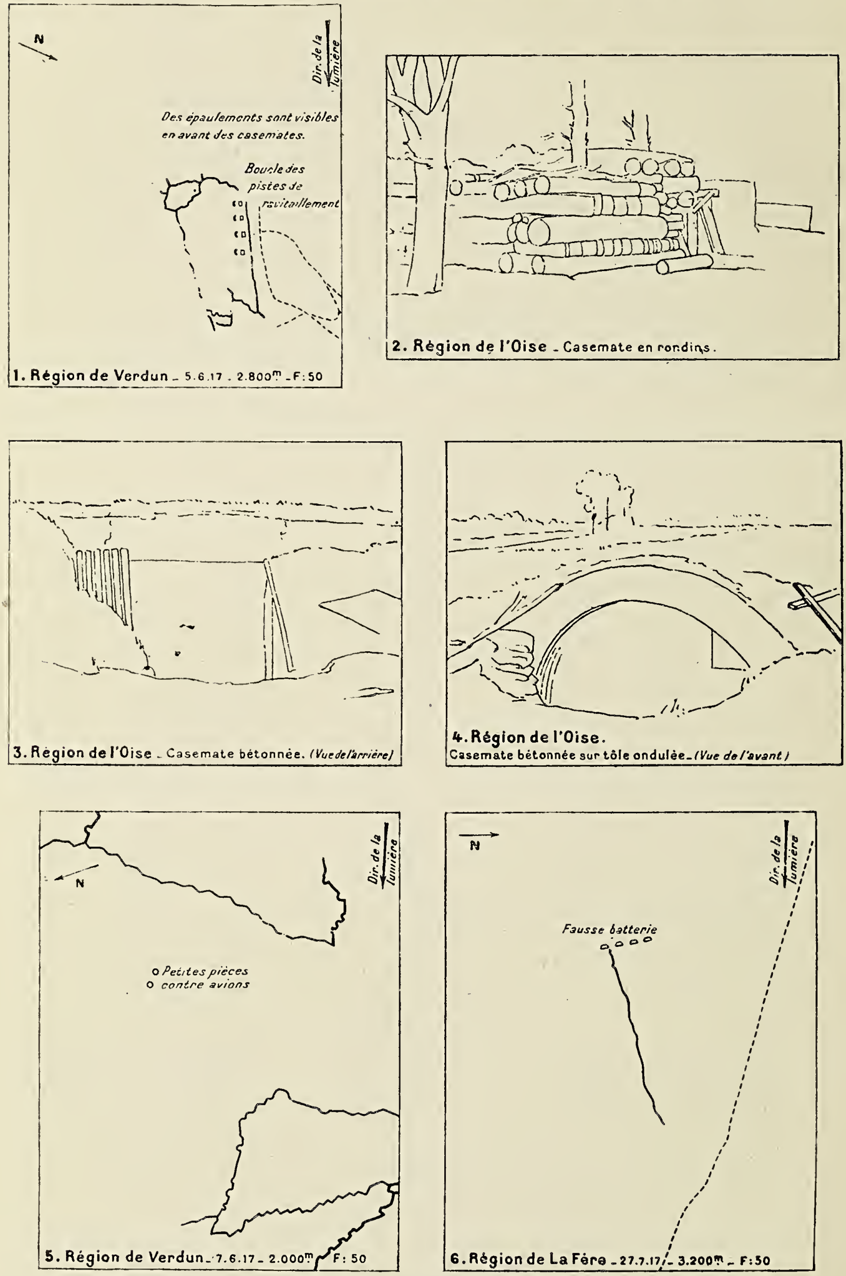
1. Underground concrete shelter for men. Depth 2.9 m. Thickness of concrete 1 m.
2. Cross-section of concrete shelter for munitions.
3. Spur of narrow-gauge railway.
4. Battery in a bank, facing enemy.
5. German 240 meter platforms.
6. Standard gauge railway.
7. Mean firing direction.
8. Standard gauge railway.
9. Concrete shelter (munitions).
10. Trench.
11. 0.6 m. narrow-gauge for small car.
12. Mean firing direction.
13. Packed gravel bottom.
14. Cross-section of platform st. AB.
15. Concrete shelter.
16. Cross-section of platform st. C. D.
17. About 18 m.
18. About 2 m.

PLATE XL.—Battery types—Casements, anti-aircraft guns, fake batteries.



1. Breastworks are visible in front of casements.—Loop of replenishing trails.
2. Log casemate.
3. Concrete casemate.
4. Concrete casemate on corrugated sheet iron (front view).
5. Small anti-aircraft guns.
6. Fake battery.

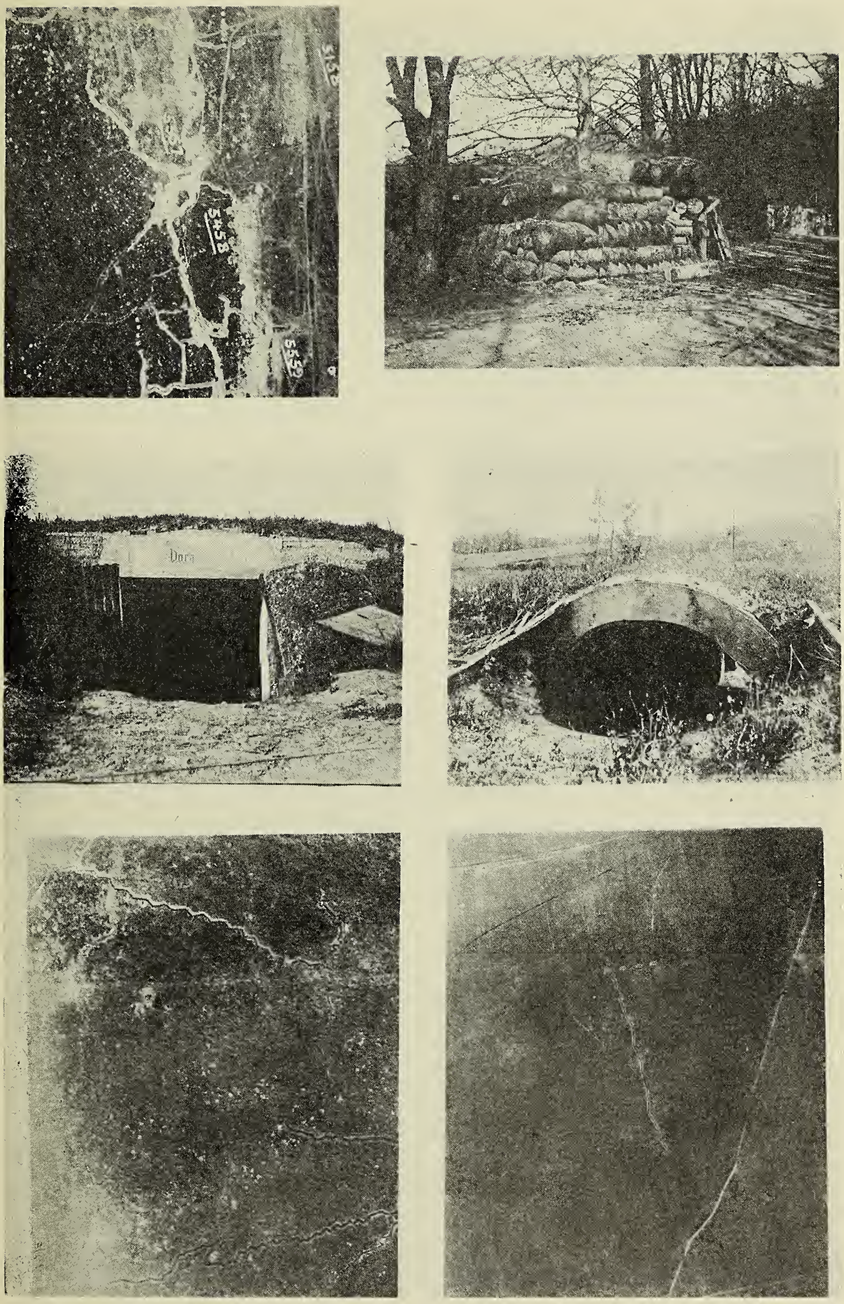
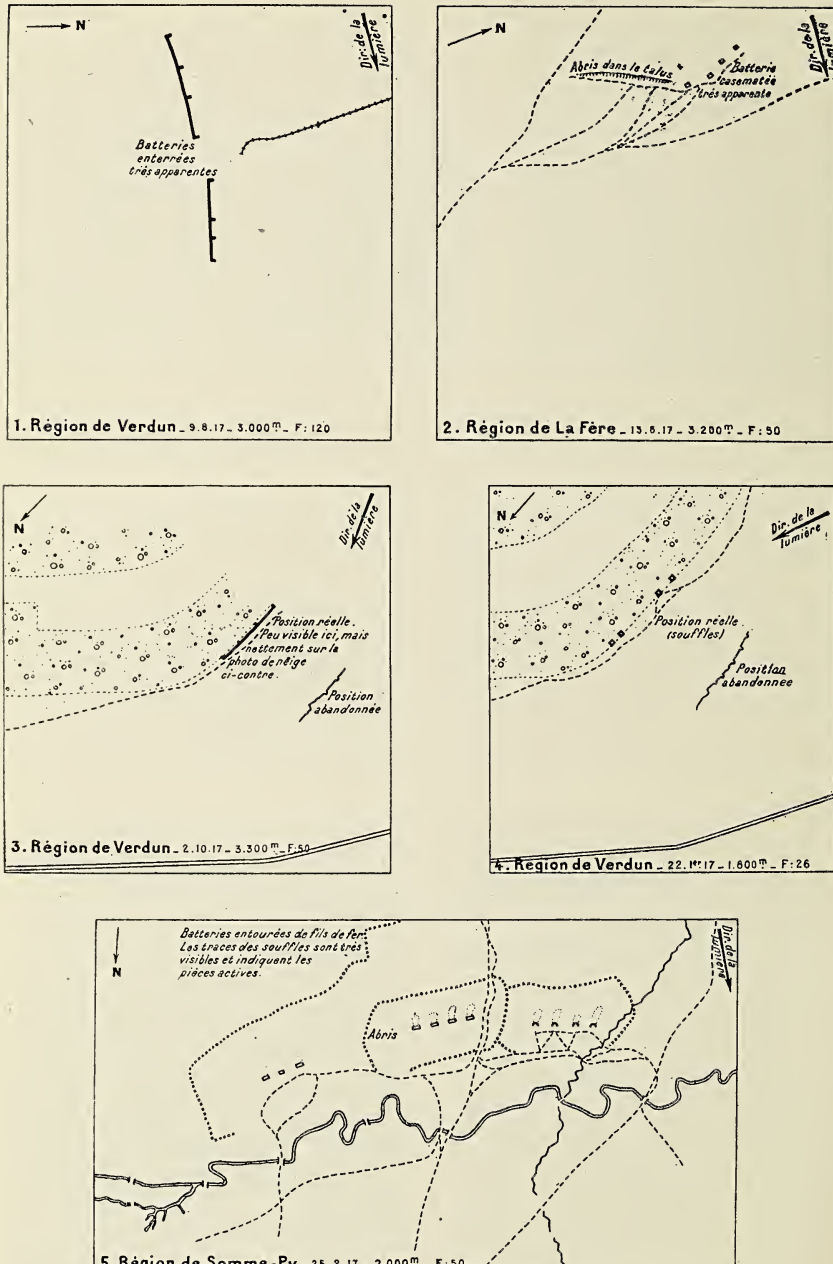


PLATE XLI.—Very apparent batteries.



1. Very evident sunken batteries.
2. Shelters in the bank.—Very apparent casemate batteries.
3. Actual position; scarcely visible here, showing plainly on opposite snow photo.—Abandoned position.
4. Actual position (blasts).—Abandoned position.
5. Batteries surrounded by wire.—Blasts are very visible, indicating activity.

PLATE XLI.

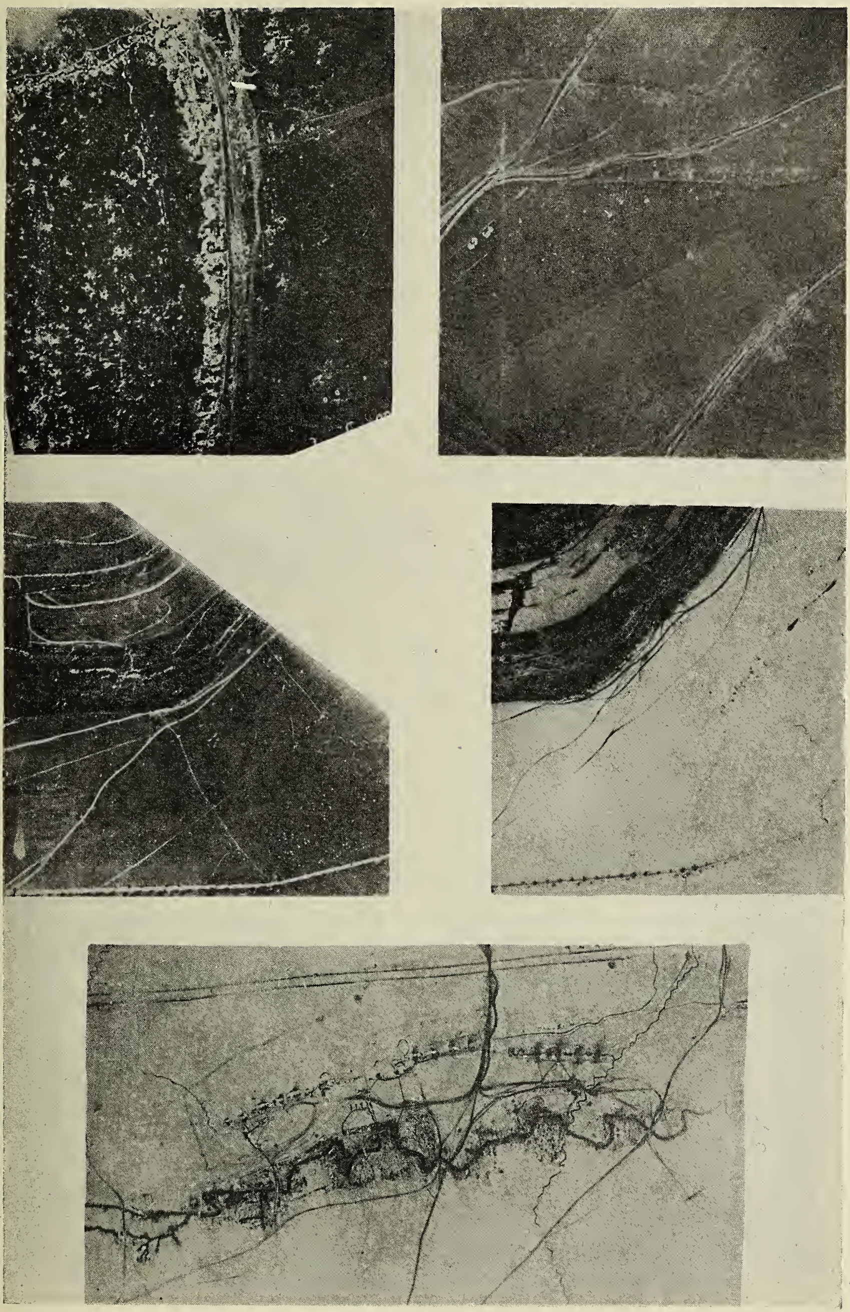
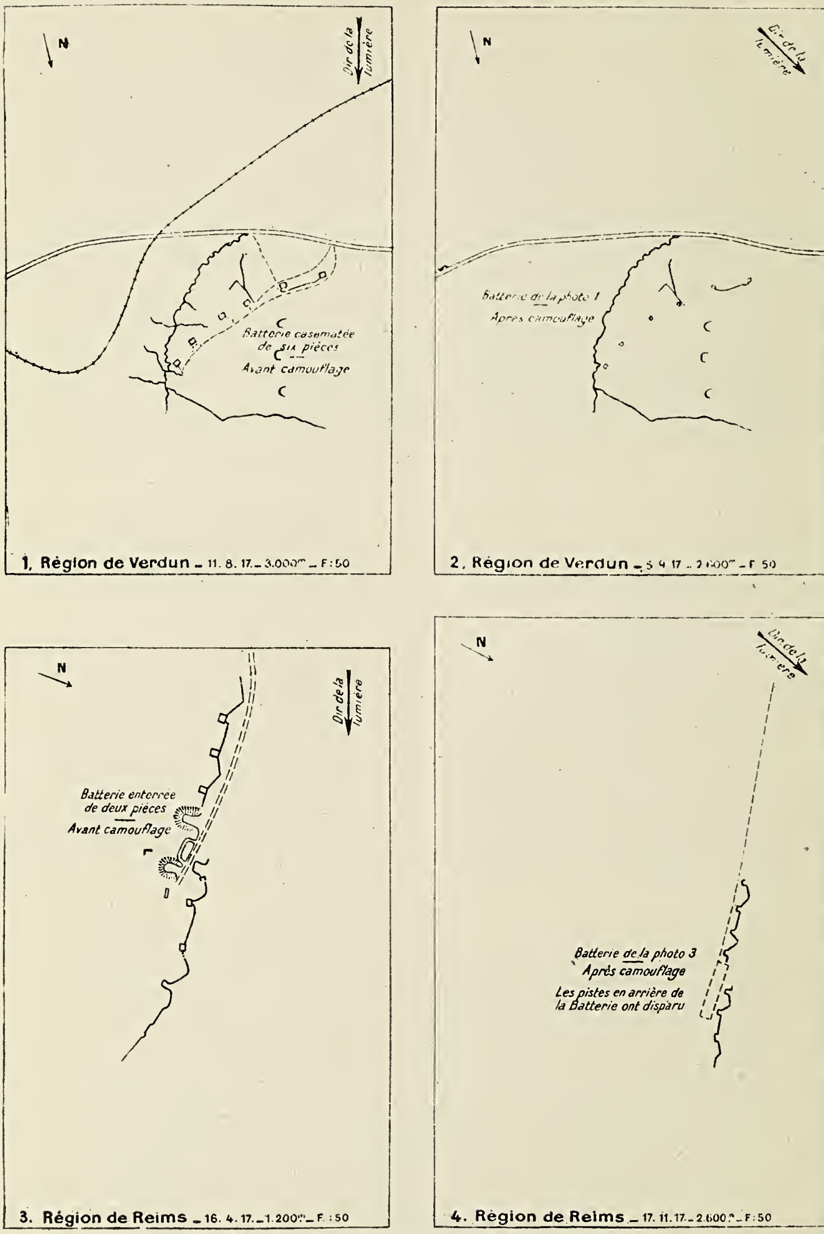


PLATE XLII.—Camouflaged batteries in open field (1).



CAMOUFLAGED BATTERIES IN OPEN FIELD.

1. Casemated battery of six guns before being camouflaged.
2. Same battery after being camouflaged.
3. Sunken battery of two guns before camouflaging.
4. Same battery after camouflaging.—Paths in rear of battery have disappeared.

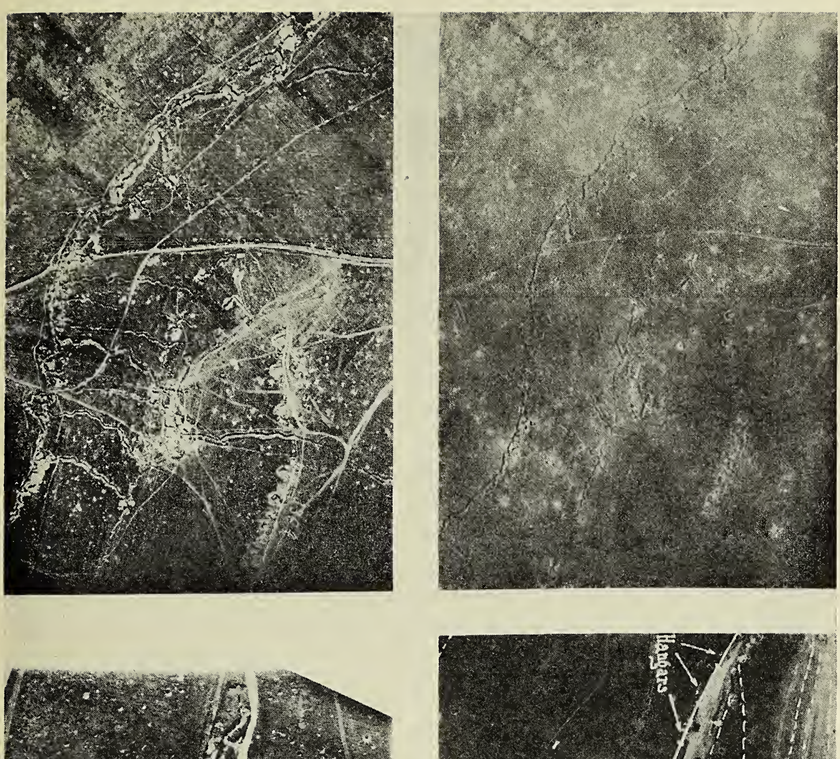
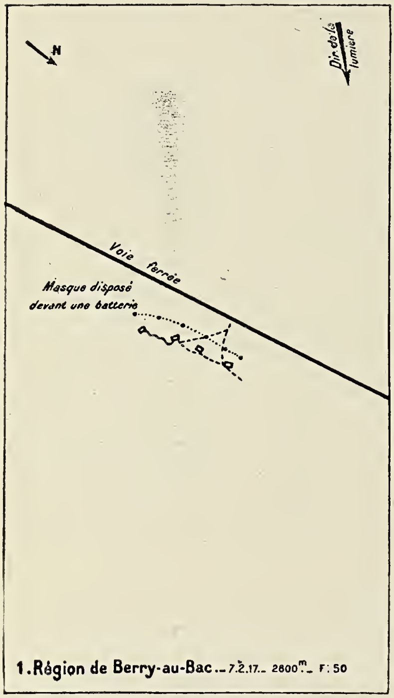
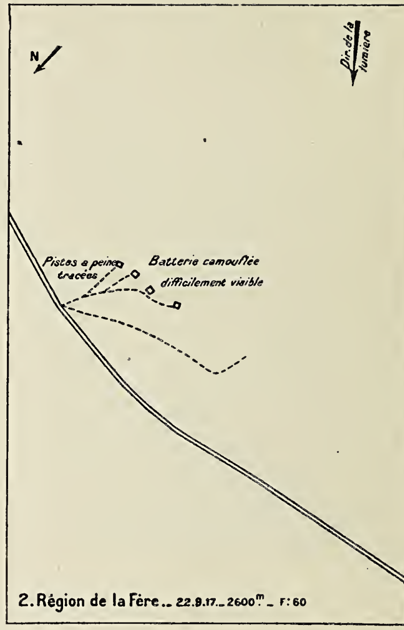

Hangars

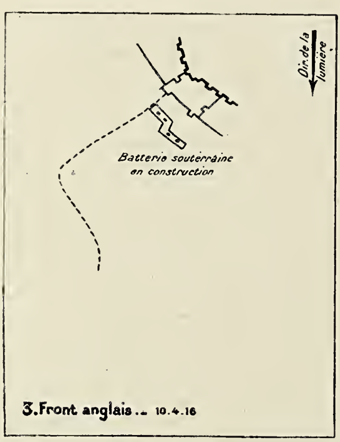
PLATE XLIII.—Camouflaged batteries in open field (2).



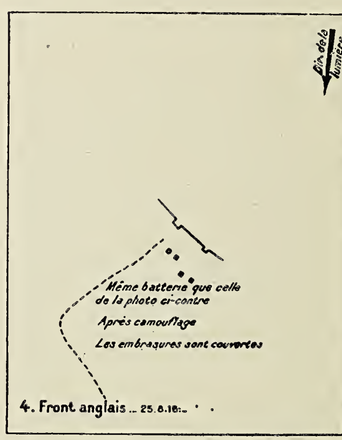
1. Région de Berry-au-Bac .. 7.2.17.. 2600m.. F: 50



2. Région de la Fère .. 22.9.17.. 2600m .. F: 60



3. Front anglais .. 10.4.16



4. Front anglais .. 25.6.16

1. Direction of light.—Railway.—Screen in front of a battery.
2. Hardly formed trails.—Camouflaged battery (difficultly visible).
3. Sunken battery under construction.
4. Same battery, with camouflage.—Embrasures covered.

PLATE XLIII

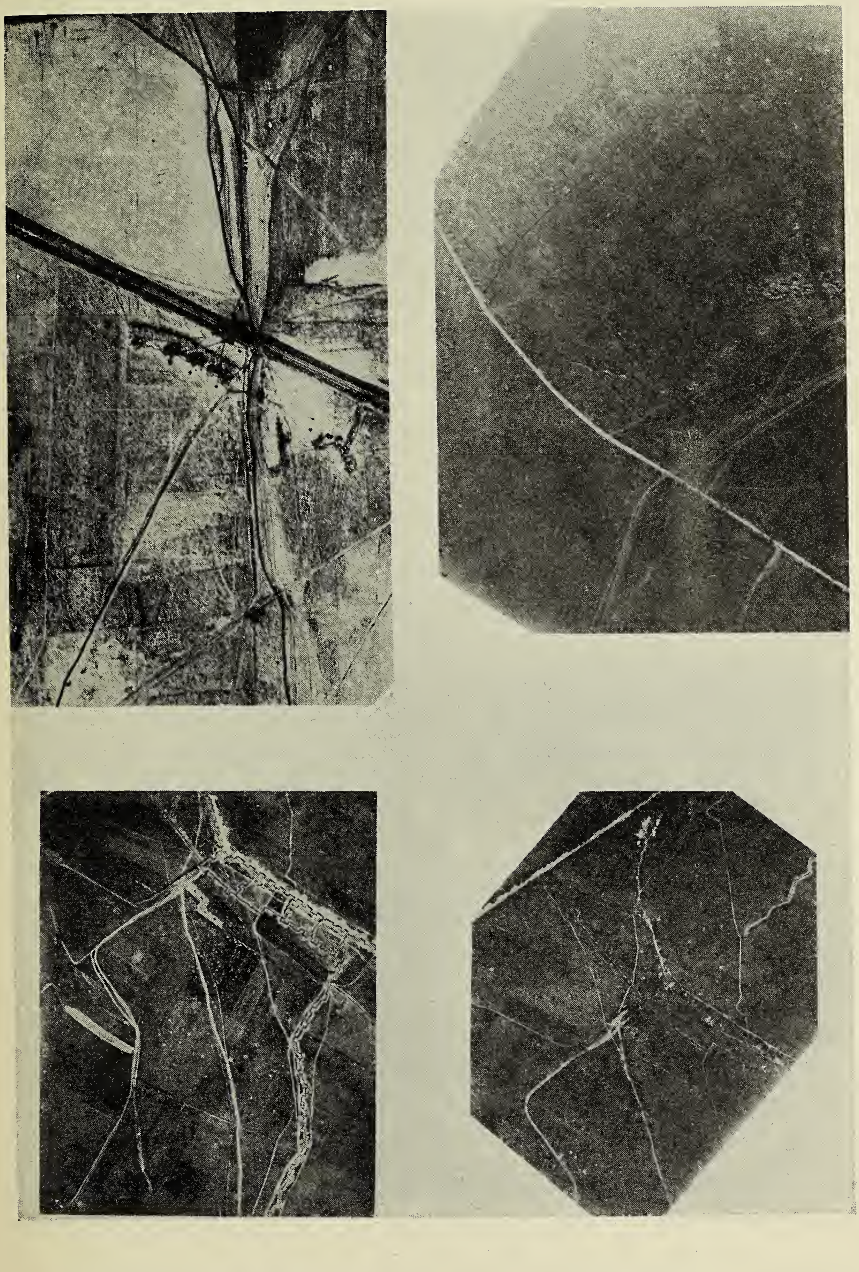
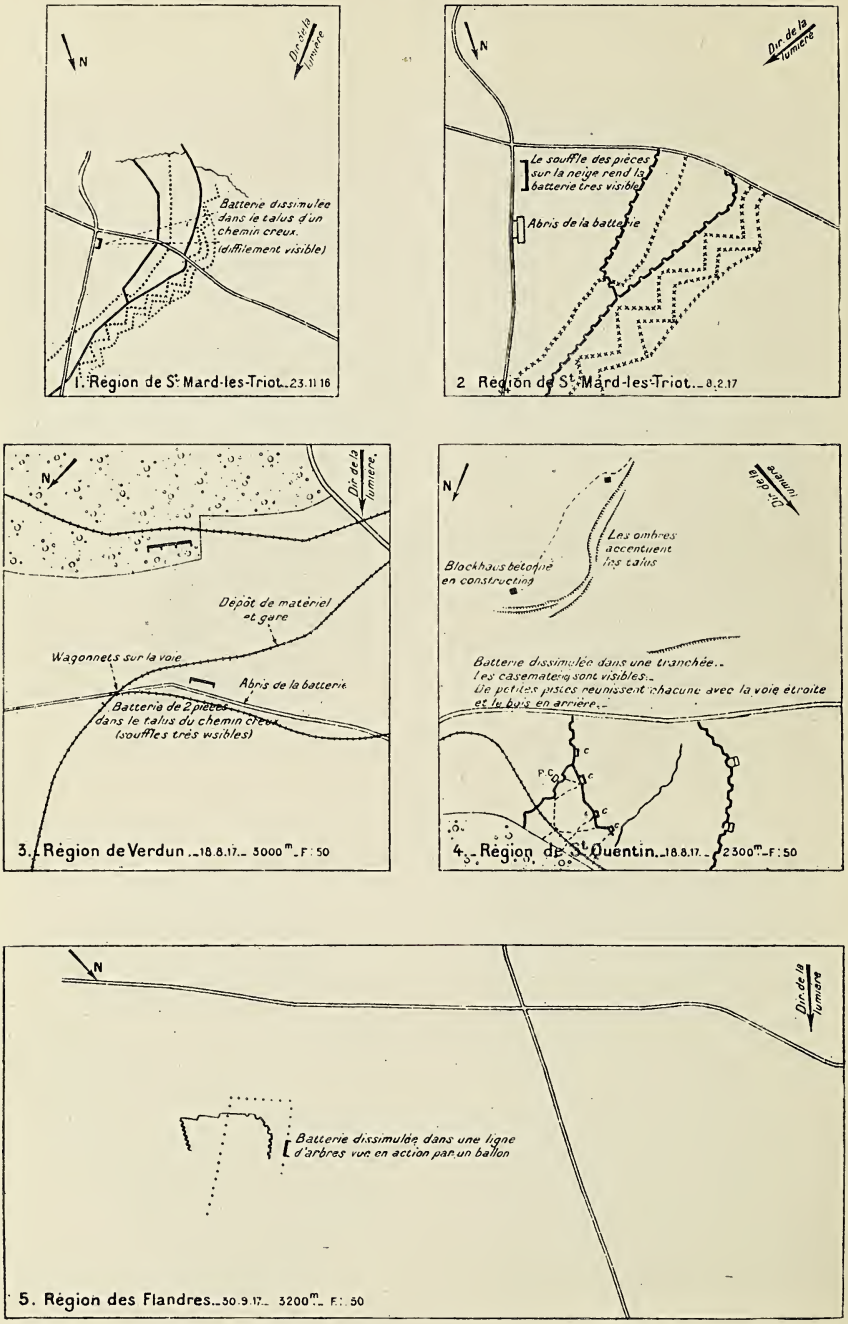


PLATE XLIV.—Concealed batteries at cross-roads, infantry works



1. Battery concealed in bank of sunken road (difficultly visible).
2. Blast of guns on snow renders battery very visible.—Dugout for battery.
3. Supply depot and railway station.—Cars on track.—Battery of two guns in bank of sunken road (very visible blasts).—Battery dugout.
4. Concrete blockhouse under construction.—Banks accentuated by shadows.—Battery concealed in trench.—Casemates visible.—Narrow paths connect each gun with narrow-gauge railway and woods in the rear.
5. Battery concealed in row of trees.—Seen in action by a balloon.

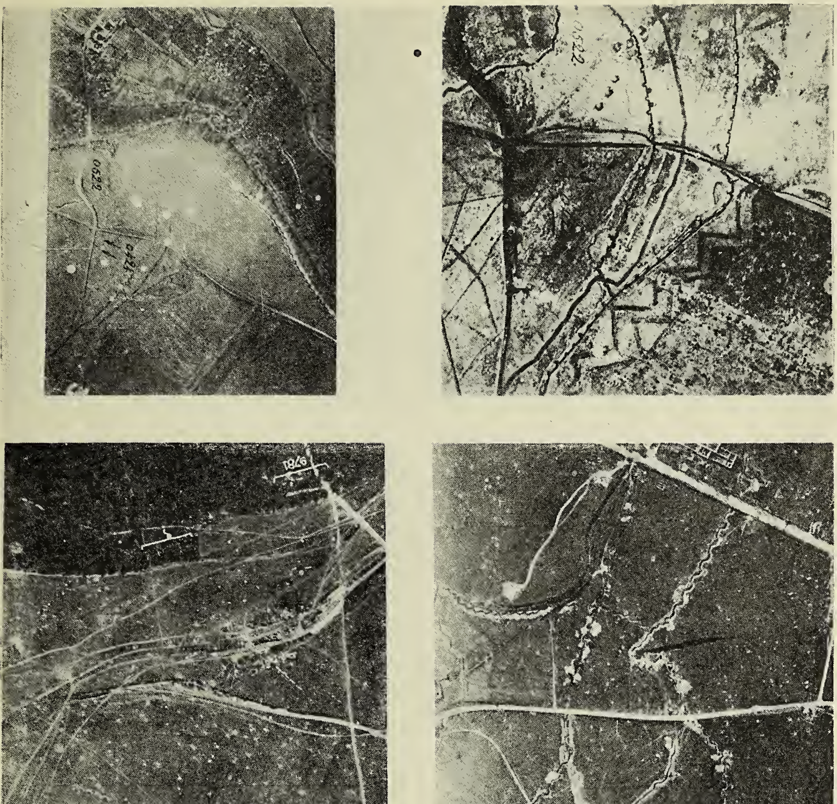
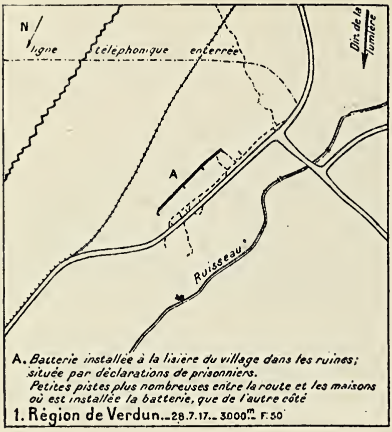
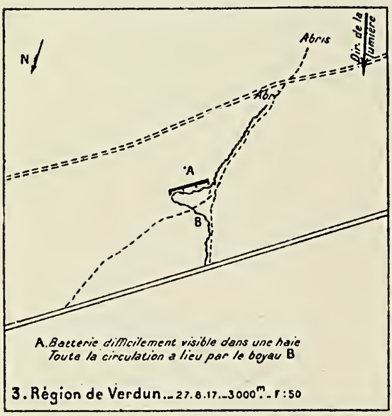
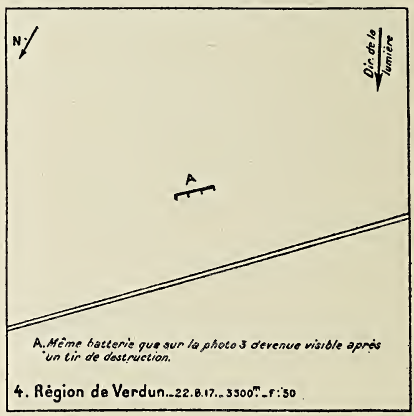
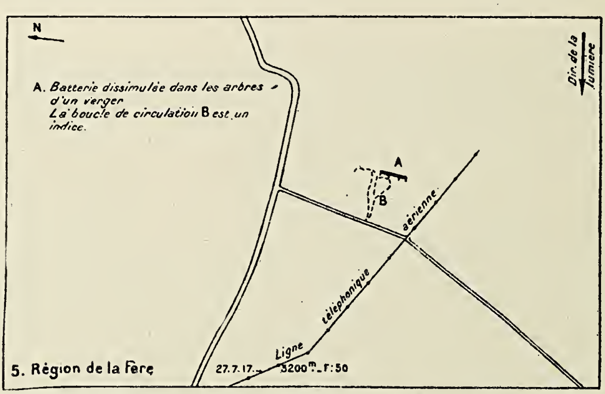


PLATE XLV.—Batteries concealed in villages, hedges, gardens.









1. A. Battery installed in ruins at edge of village, located by statements of prisoners.—Small paths more numerous between road and houses, where battery is installed.
2. A. Battery in a village.—Gun pits and service trench.—B. Unused station.—Tracks have been removed.—See on this snow photo the paths in the village streets (13 km. from the front).
3. A. Battery difficultly visible in a hedge.—All circulation is through trench B.
4. A. Same battery, made visible by demolition fire.
5. A. Battery concealed in an orchard.—Loop of circulation B is an indication.

PLATE XLV.

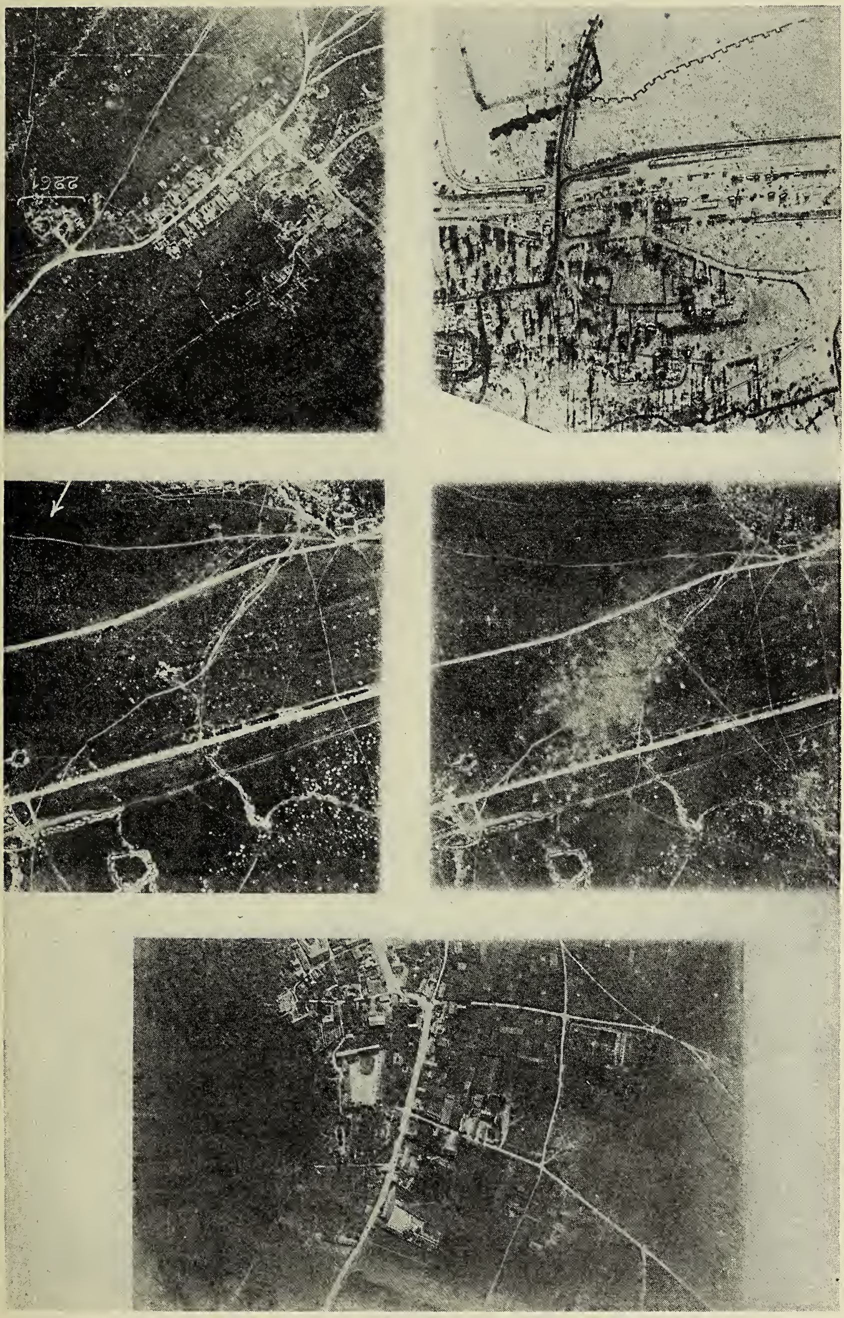


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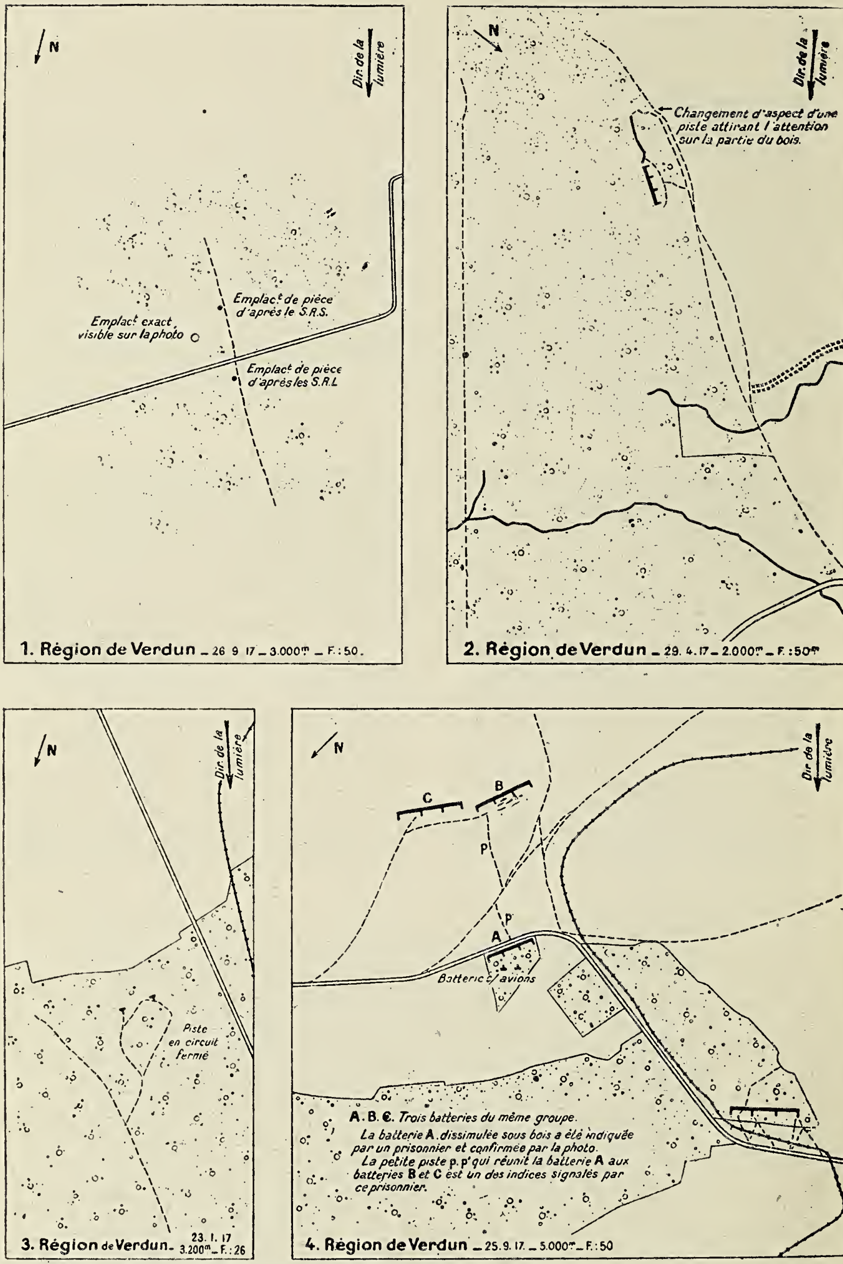
PLATE XLVI.—Batteries in woods (1).



1. Direction of light.—Location of gun according to section of locating by sound.—According to section of locating by flashes.—Exact location shown on photo.
2. Changed appearance of trail, drawing attention to the woods.
3. Trail in closed circuit.
4. Anti-aircraft battery.—A, B, C. Three batteries of same group. Battery A, concealed in woods, was indicated by a prisoner and confirmed by the photo. The small path p-p′, connecting battery A with batteries B and C, is one of the indications mentioned by prisoner.

PLATE XLVI.

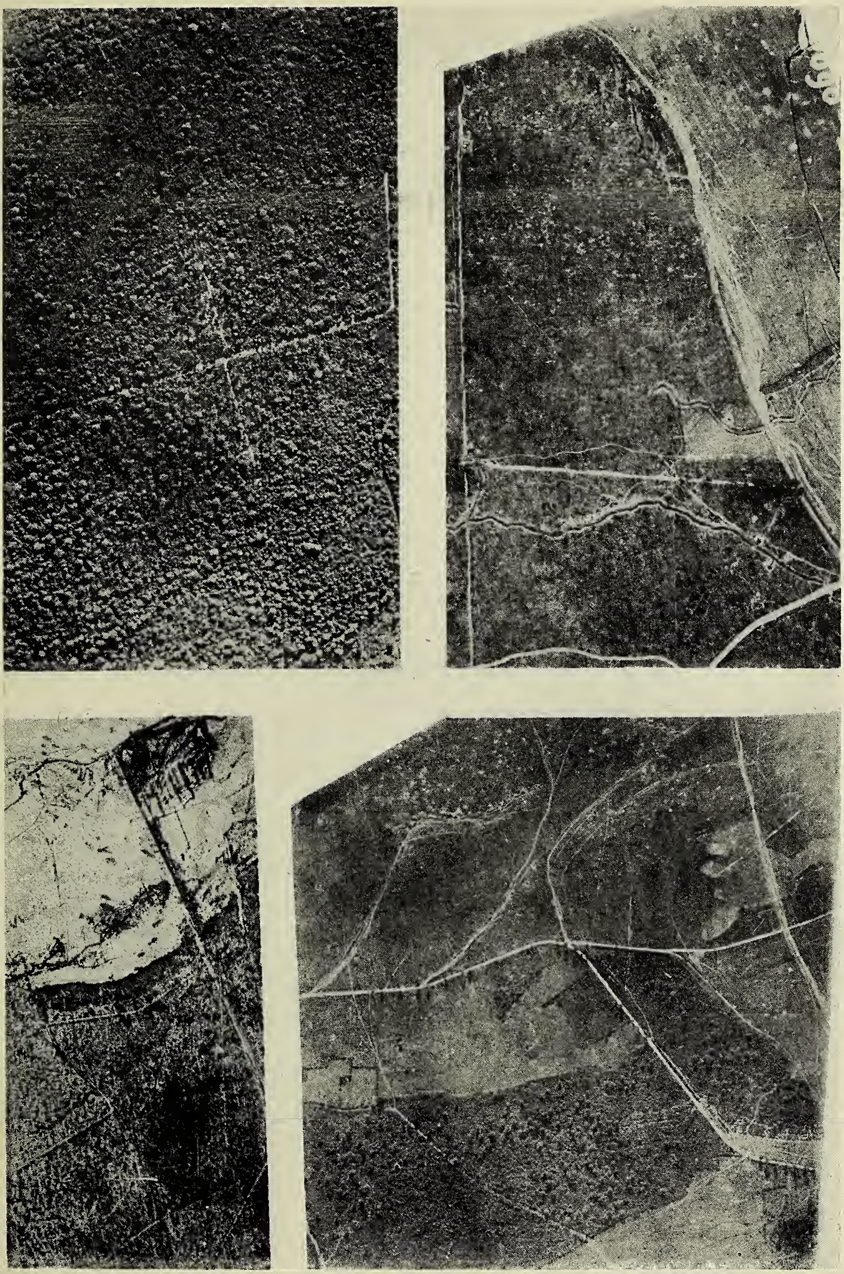
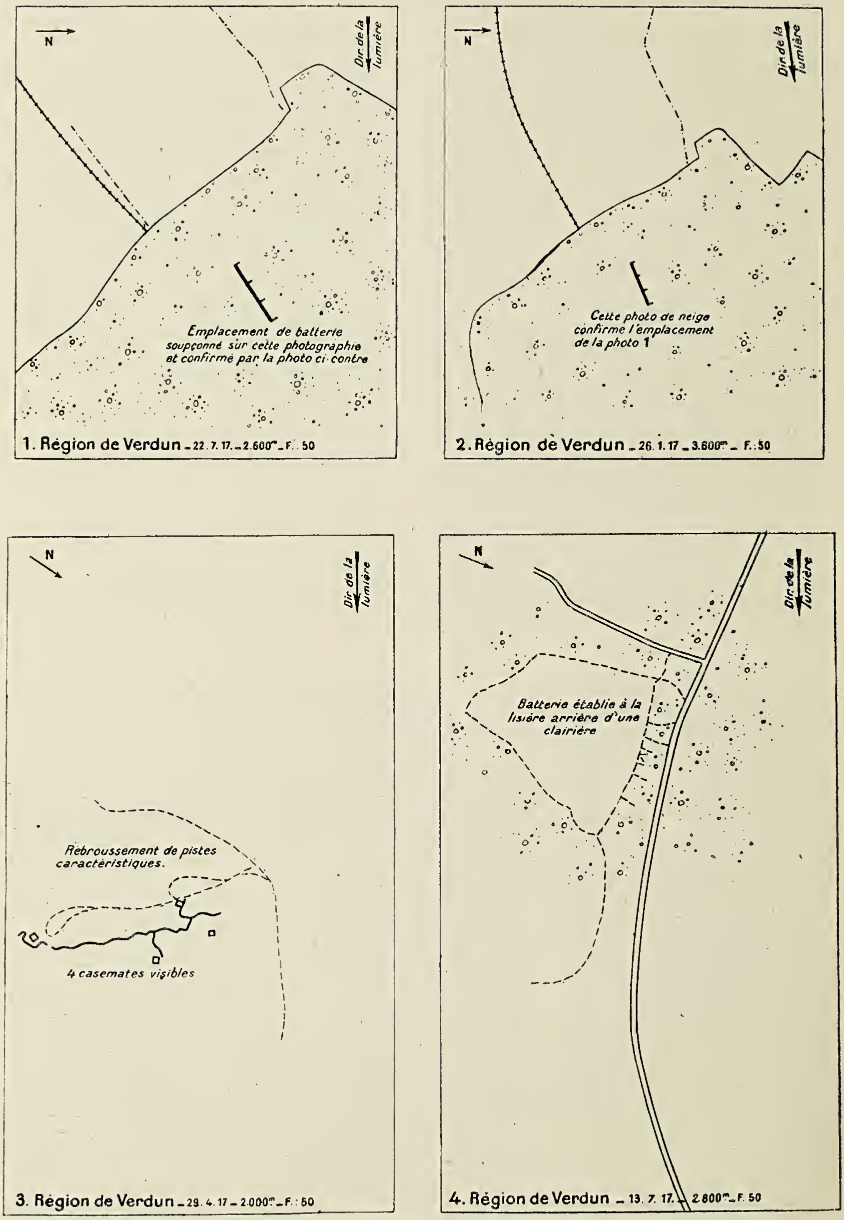


PLATE XLVII.—Batteries in woods (2).



1. Battery emplacement suspected on this photo and confirmed on adjoining photo.
2. This snow photo confirms emplacement of photo 1.
3. Characteristic loops of paths.—Four visible casemates.
4. Battery at rear edge of clearing.

PLATE XLVII.

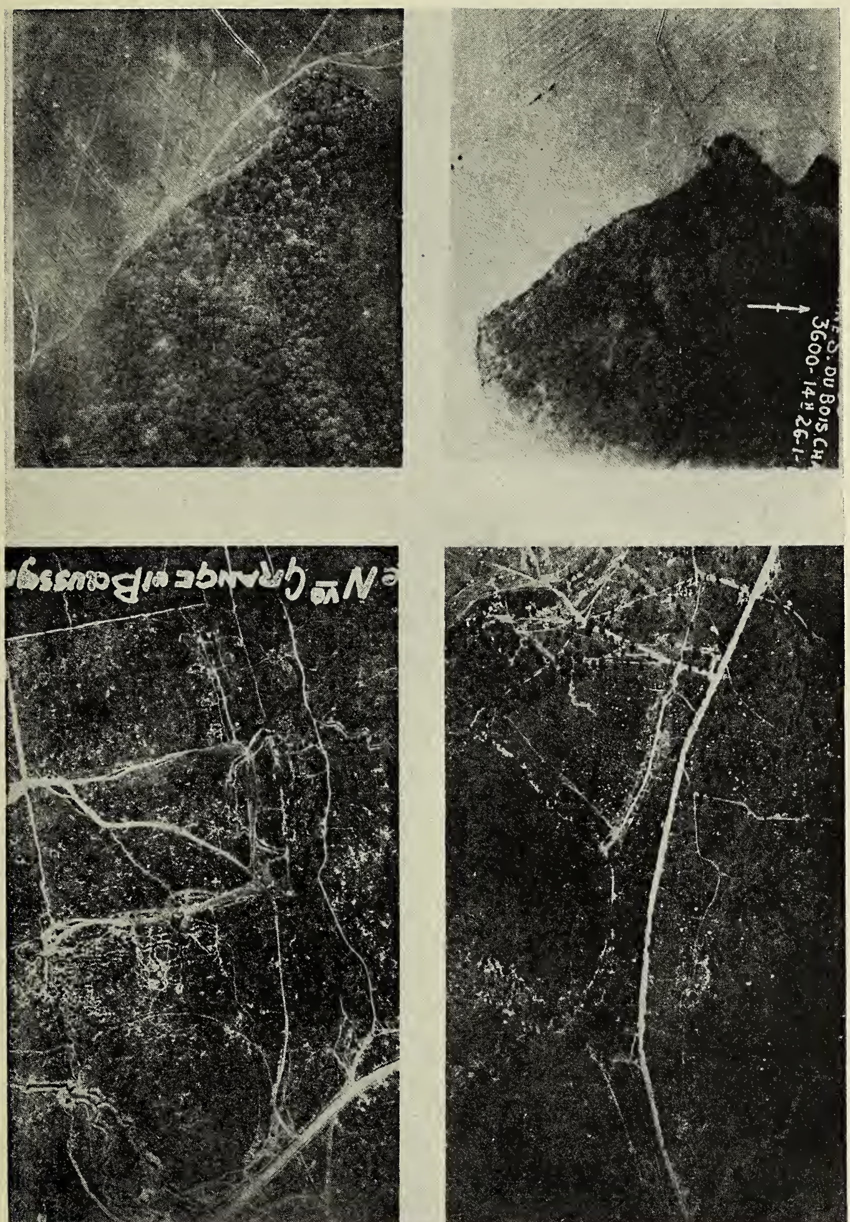
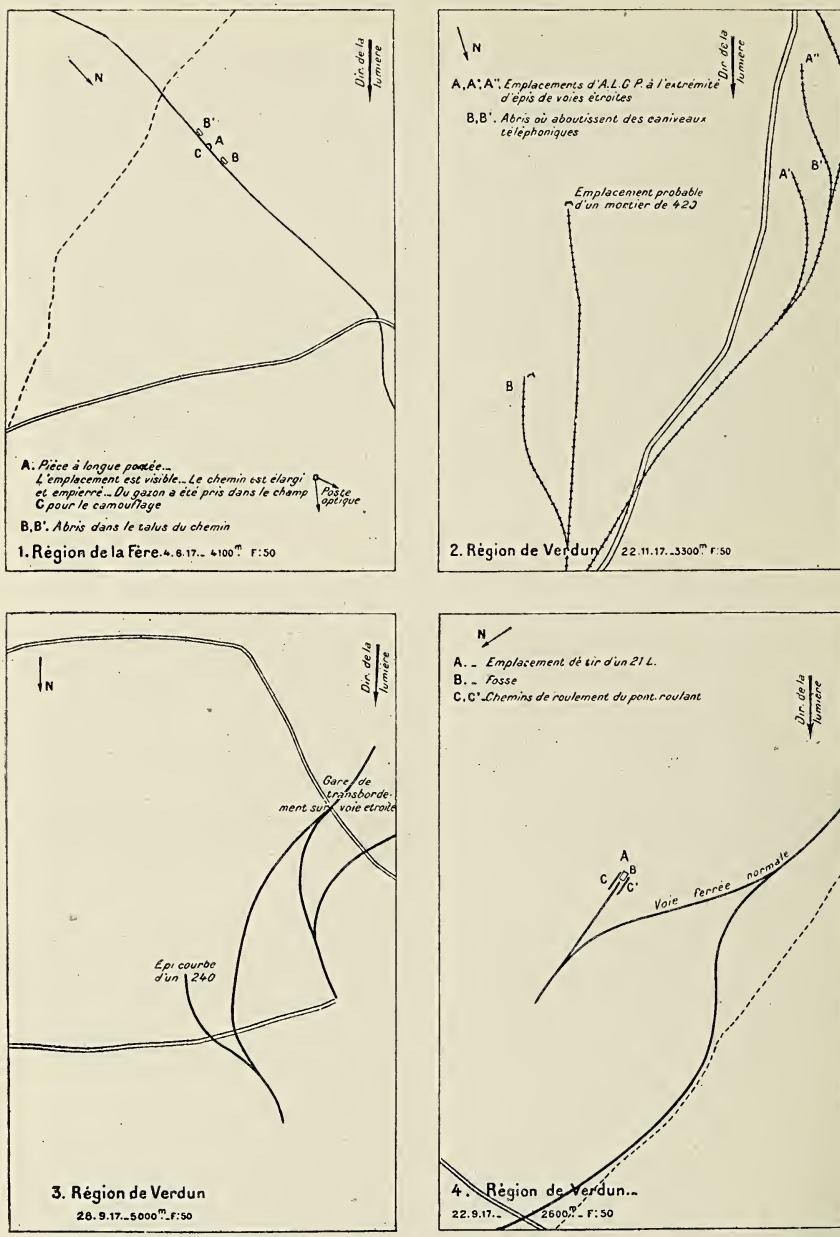
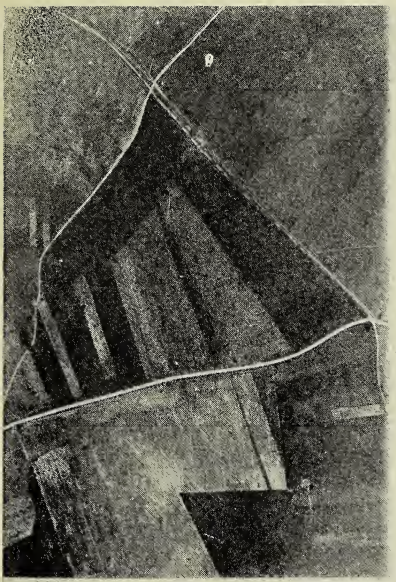


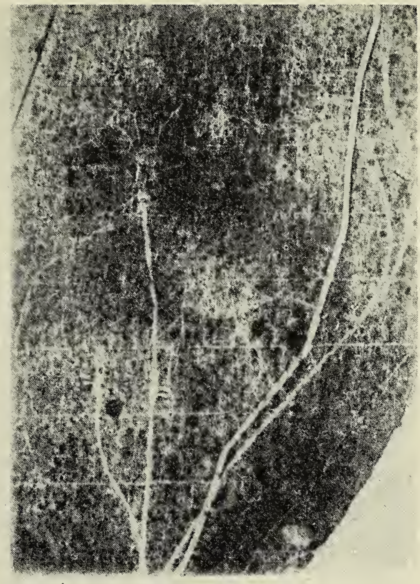
PLATE XLVIII.—Positions of high-powered heavy artillery (1).

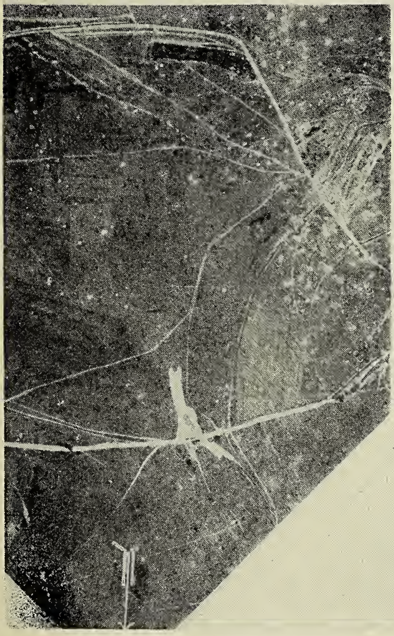


1. A. Long-range gun.—Emplacement is visible.—Road is widened and macadamized.—Cloth was used for camouflage in field C.—B, B′. Shelters in road bank.—Visual signaling post.
2. A, A′, A″. Emplacements of high-powered heavy artillery at end of spur track of narrow-gauge railway.—B, B′. Shelters at end of telephone conduits.—Probable emplacement of a 420 mm. mortar.
3. Transshipping station on narrow-gauge railway.—Curved spur track of a 240.
4. A. Emplacement of a 21 L.—B. Ditch.—C, C′. Tracks for rolling platform.

PLATE XLVIII.







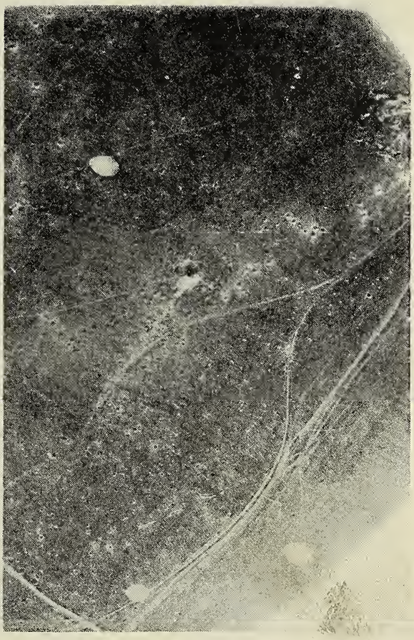
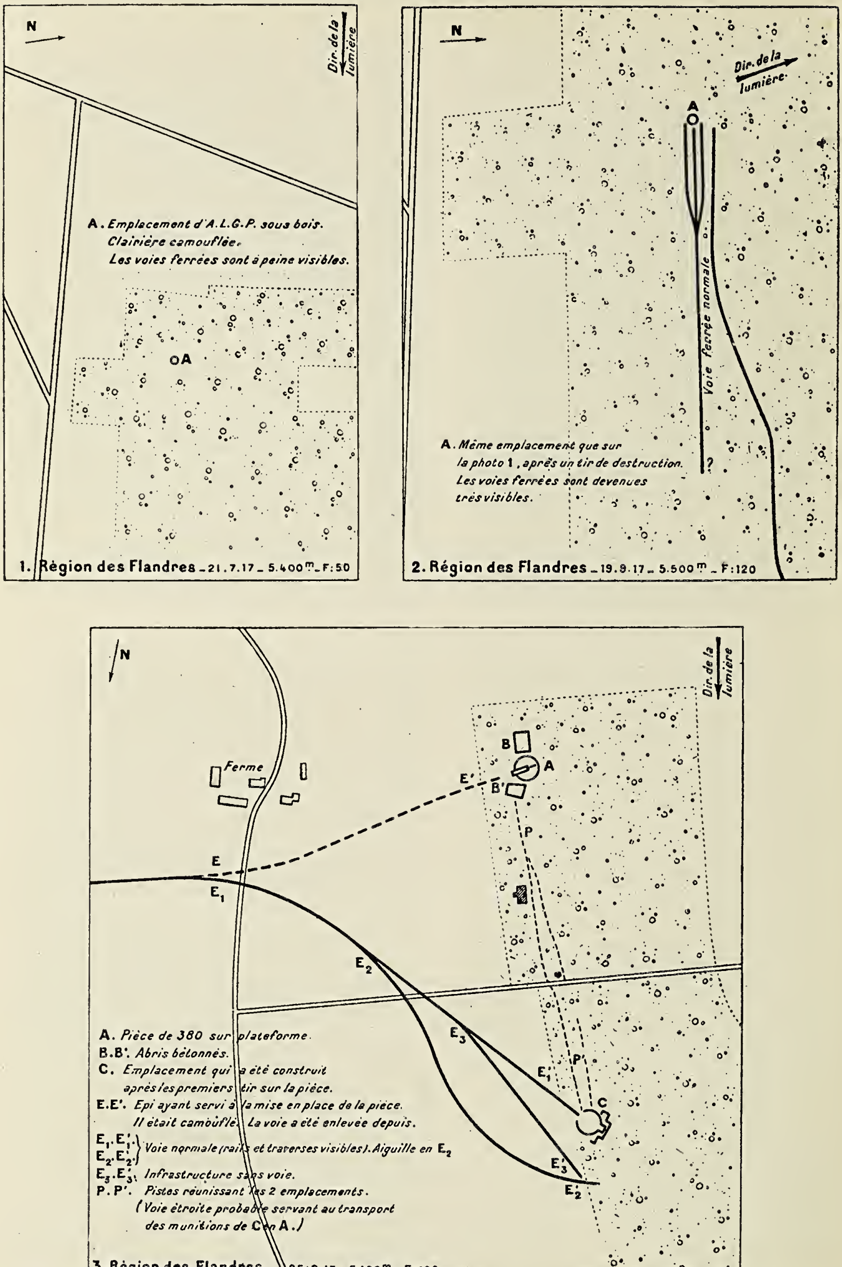
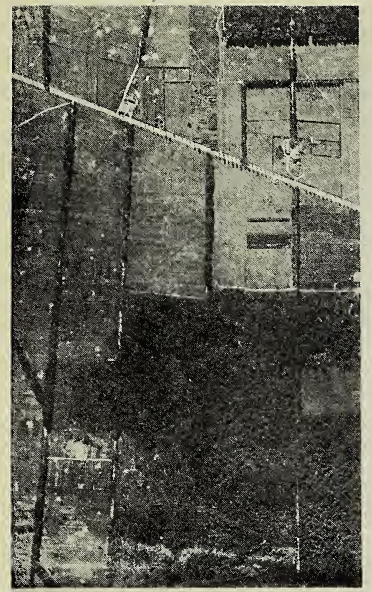


PLATE XLIX.—Positions of high-powered heavy artillery (2).



1. Emplacement of high-powered heavy artillery in woods.—Clearing camouflaged.—Railways are hardly visible.
2. A. Same emplacement as on photo 1, after demolition fire.—Railways have become very visible.
3. A. 380 mm. gun on platform.—B, B′. Concrete shelters.—C. Emplacement constructed after first firing at the gun.—E, E′. Spur track which served for placing gun.—It was camouflaged.—Rails have since been removed.—E_1, E_1, E_2, E_2. Standard-gauge railway (rails and ties visible); spur at E_2.—E_3, E_3. Inside road without rails.—P, P′. Paths connecting the two emplacements.—Probable narrow-gauge railway for transporting munitions from C to A.

PLATE XLIX.



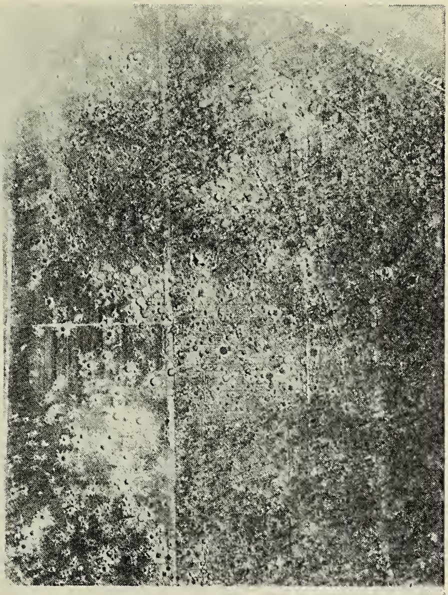
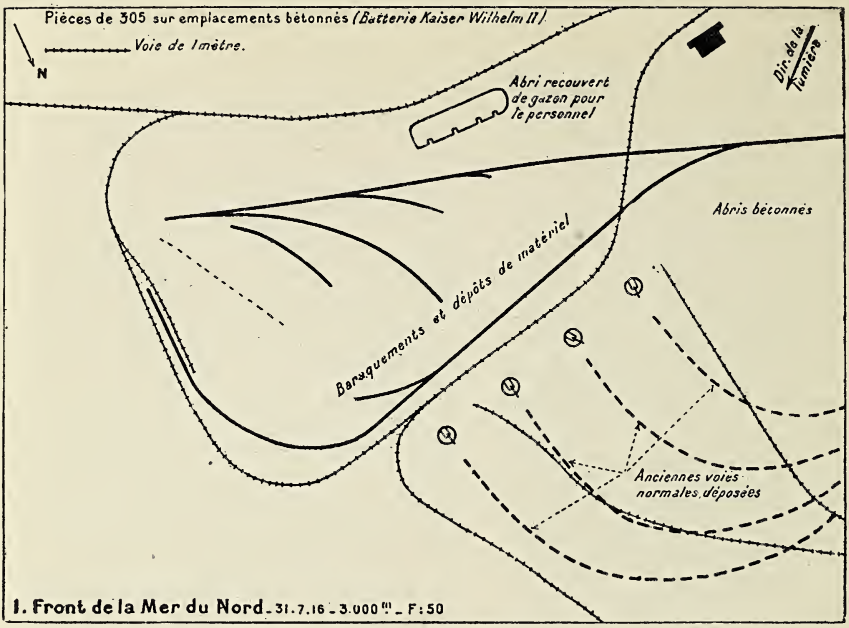
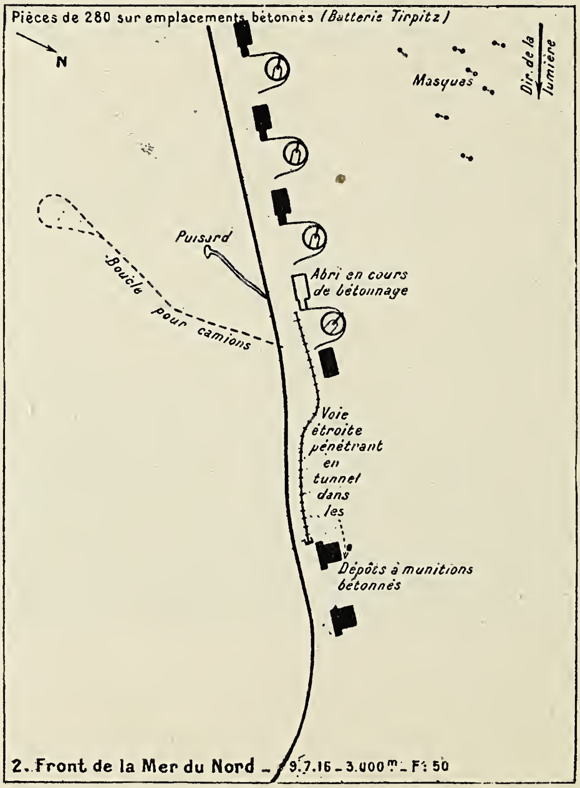
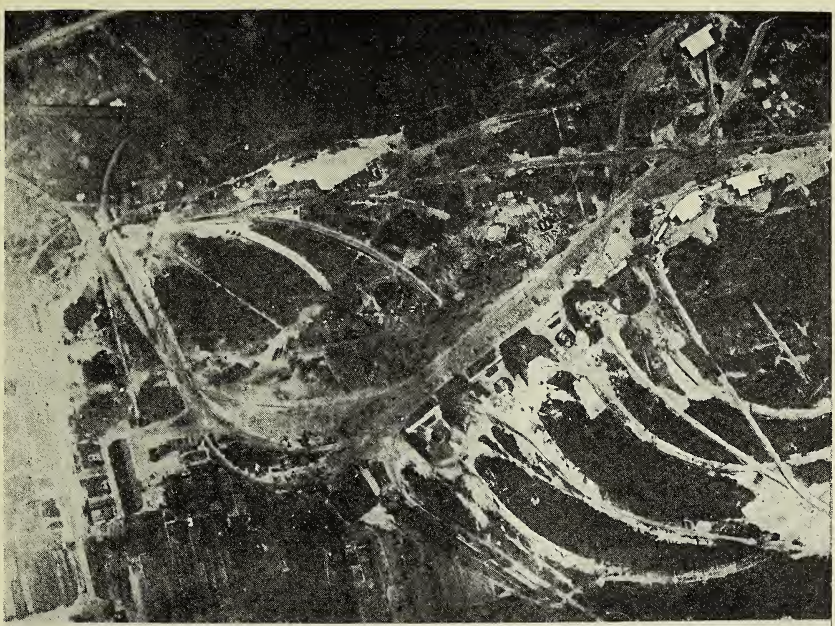


PLATE L.—Positions of high-powered heavy artillery (3) coast batteries.





1. North Sea front.—305 mm. guns on concrete emplacements.—1 m. railway.—Sod-covered shelter for the men.—Concrete shelters.—Barracks and supply depots.—Old standard-gauge railways removed.
2. 280 mm. guns on concrete emplacements.—Cesspool.—Loop for trucks.—Screens.—Shelter being concreted.—Narrow-gauge railway entering concrete munition depots through tunnel.



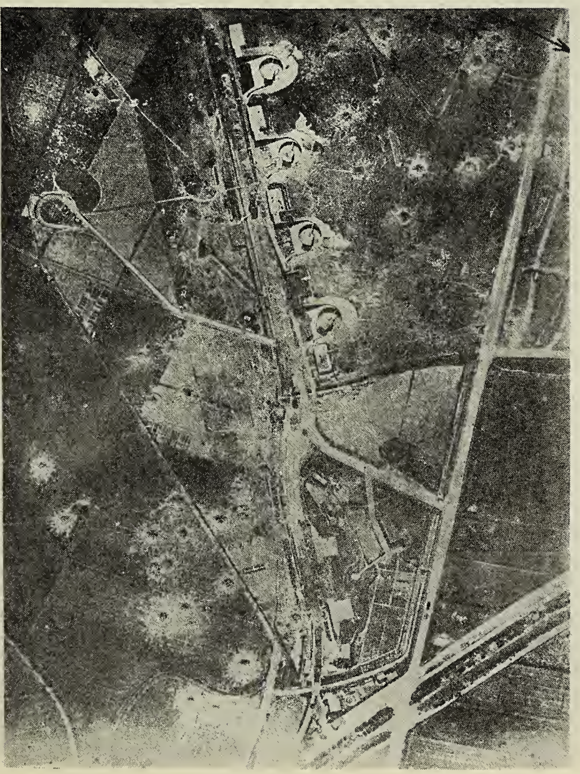
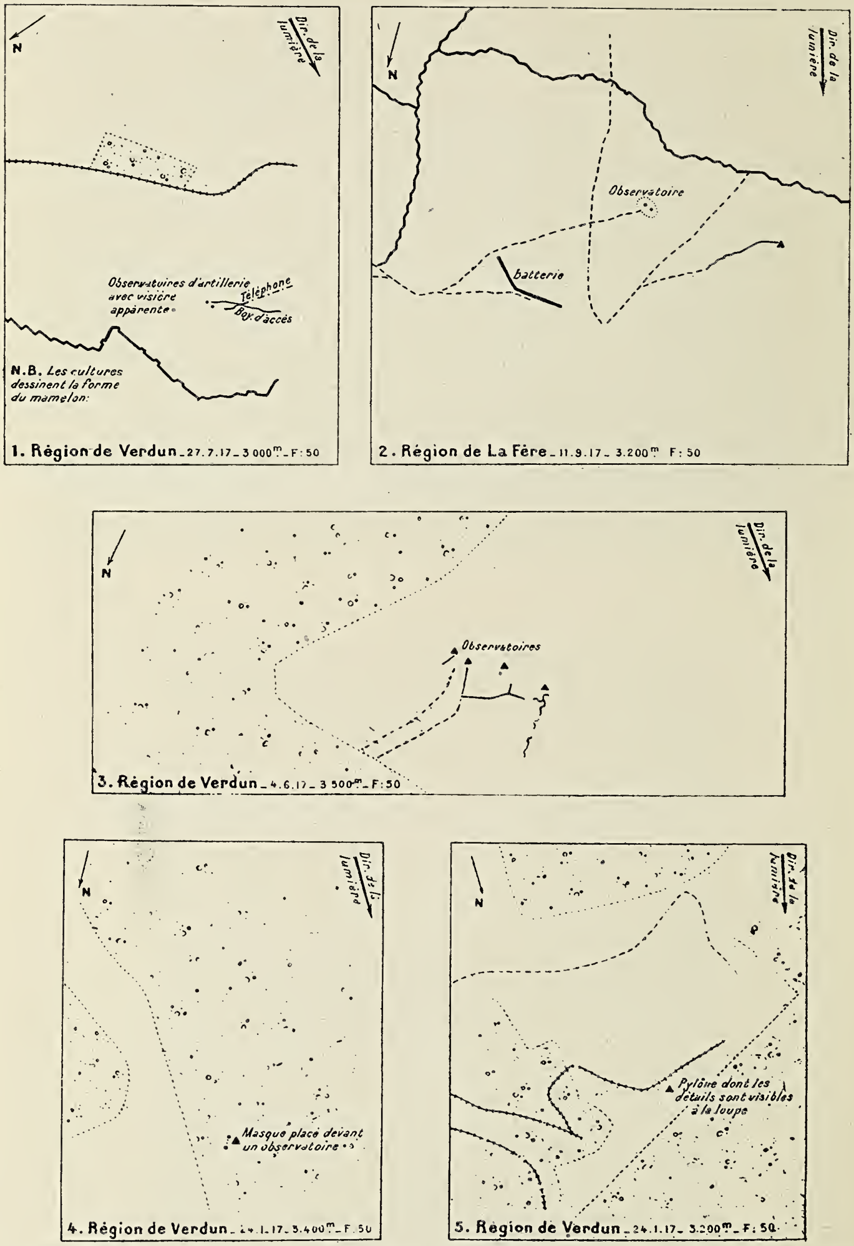


PLATE LI.—Artillery observation stations.



1. Artillery observation stations showing embrasures.—Telephone. Communicating trench.—N. B. The cultivation shows form of hill.
2. Observation station.—Battery.
3. Observation stations.
4. Screen in front of observation station.
5. Pylone whose details are visible with a magnifying glass.

PLATE LI.

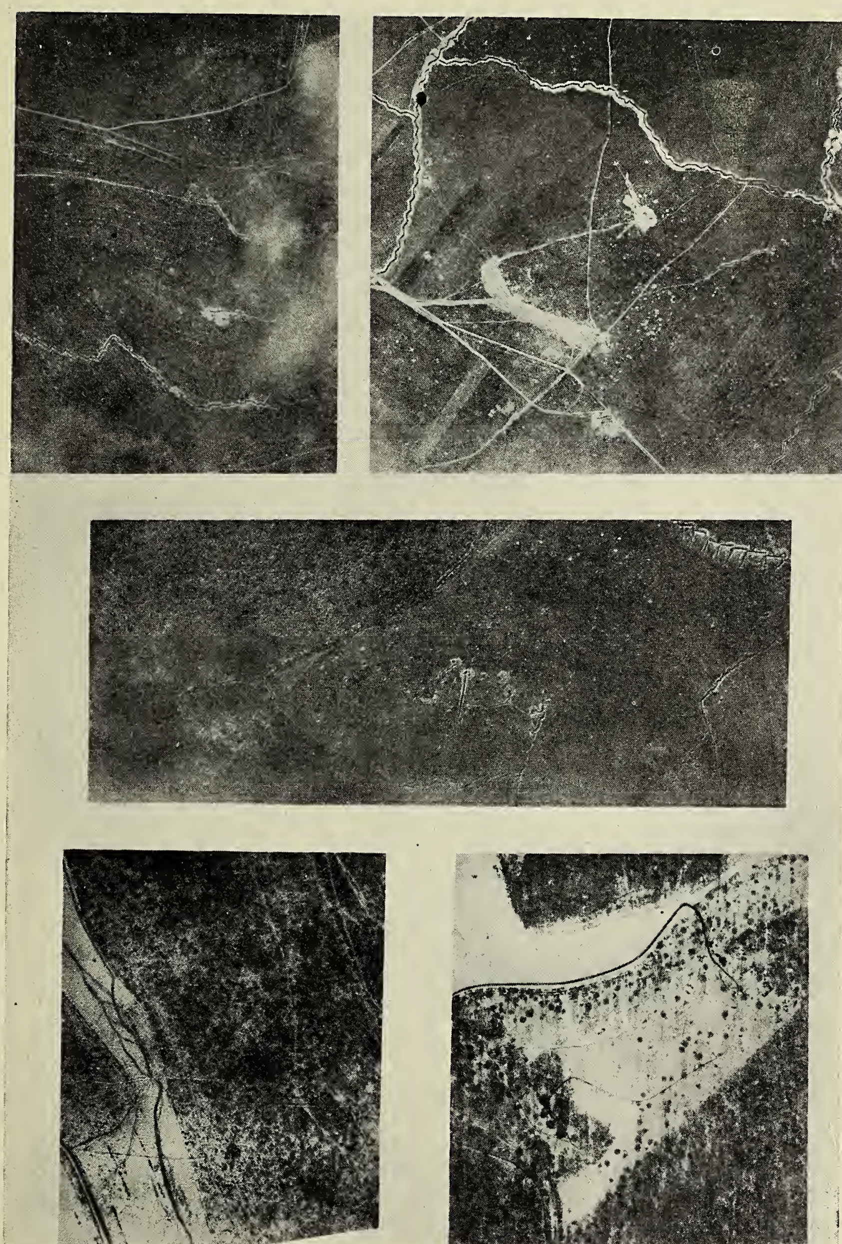


PLATE LII.[a]—Communications in a divisional sector—Diagram from a German document.

ORGANIZATION OF A GERMAN DIVISION ACCORDING TO A GERMAN SKETCH.

Division limit.

Regiment limit.

Headquarters of artillery regiment.

Headquarters of infantry regiment.

Artillery observation post.

At all artillery observation stations are permanent posts for barrage firing. In order to give a clearer view of the whole, these posts are not shown on the sketch, and where there are several observation posts, they are marked by the symbol to denote the correlation of all the means of liaison.

Extra emplacements.

Servi par

Occupied emplacements.

Infanterie-l'Artillerie

Permanent post for ordering barrage firing.

Fog post.

Post for sending messages by projectiles.

Post of hand siren.

Post of oxygen siren.

Post of courier.

Chain of machine guns.

VISUAL SIGNAL STATIONS.

Stations with large equipment.

Stations with medium equipment.

Stations for infantry liaison with balloons.

Stations of telephone detachment No. 407.

Infantry stations.

Artillery stations.

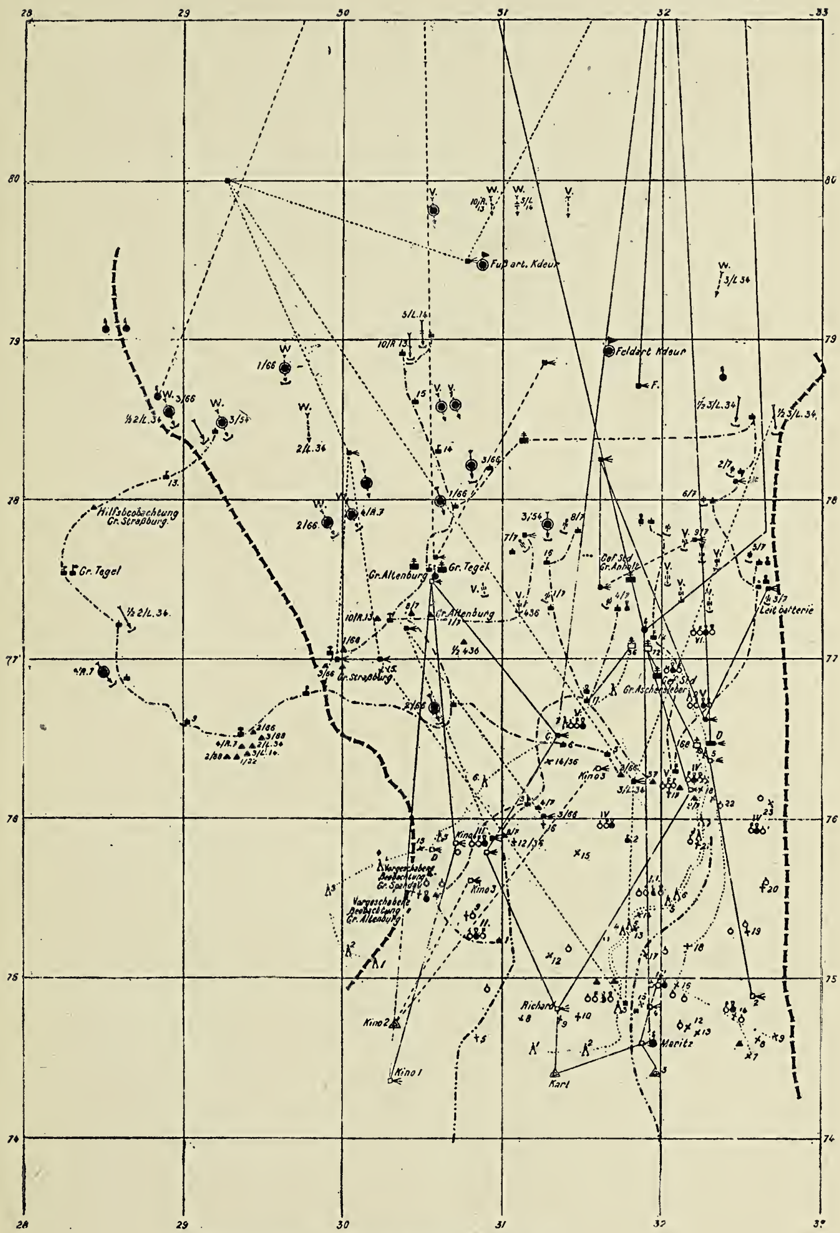
Stations being constructed.

Stations planned.

Radio stations for reciprocal transmissions.

Radio stations for transmission in one direction

PLATE LII.b



Hilfsbeobachtung.—Auxiliary observation post.
Vorgeschobene Beobachtung.—Advanced observation post.
Leitbatterie.—Leading battery.

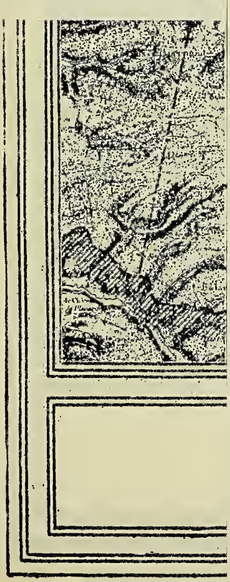


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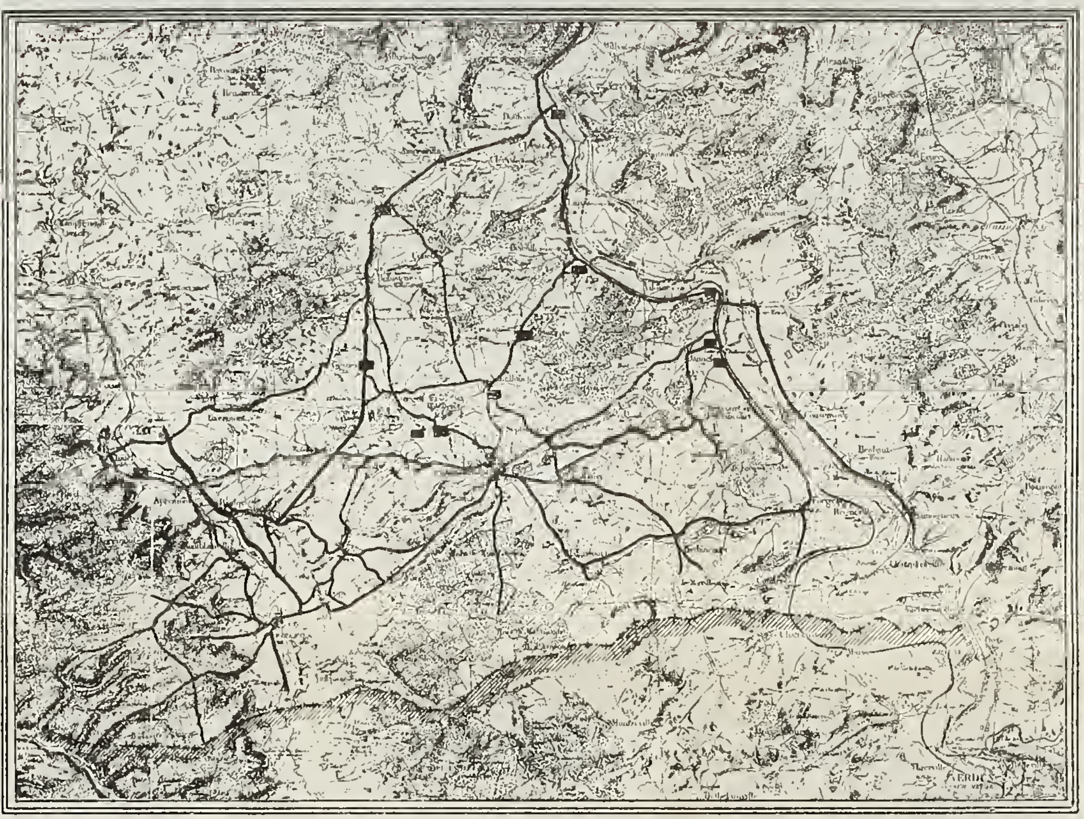
PLATE LIII.[a]—Ammunition Depots (1) Diagram of roads serving them.



SYSTEM OF ROADS SERVING MUNITION DEPOTS OF A SECTOR.

SYSTEM OF RAILWAYS SERVING MUNITION DEPOTS OF A SECTOR.

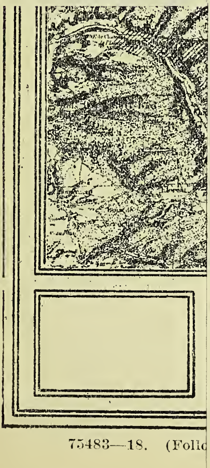


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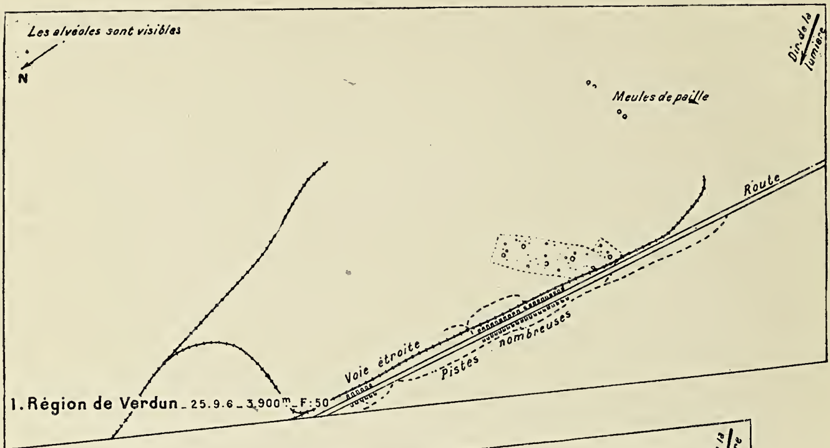
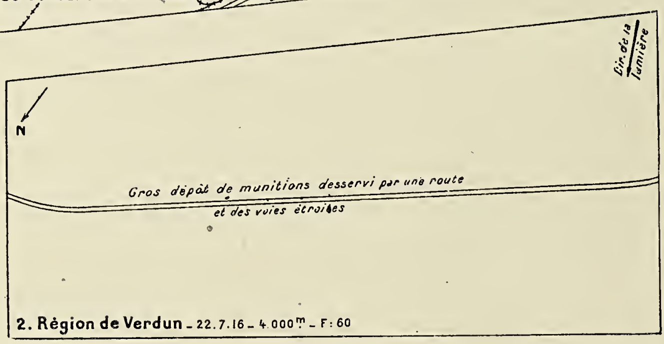
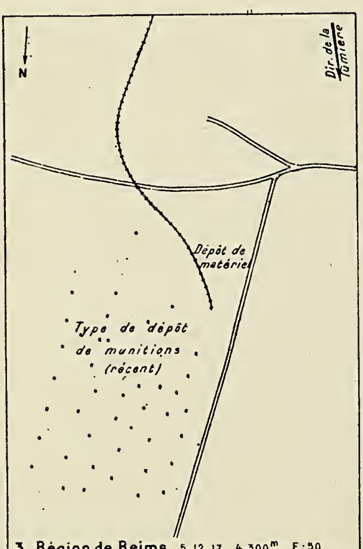
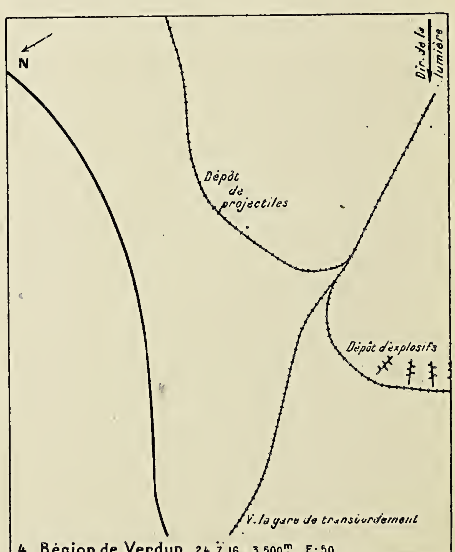
DIAGRAM OF MUNITION REPLENISHMENT OF A SECTOR.

PLATE LIV.—Ammunition depots (2).









1. Gun pits are visible.—Stacks of straw.—Narrow-gauge railway.—Numerous paths.
2. Large munition depot served by highway and narrow-gauge railways.
3. Supply depot.—Type of munition depot (recent).
4. Depot of projectiles.—Depot of explosives.—Toward transshipping station.

PLATE LIV.

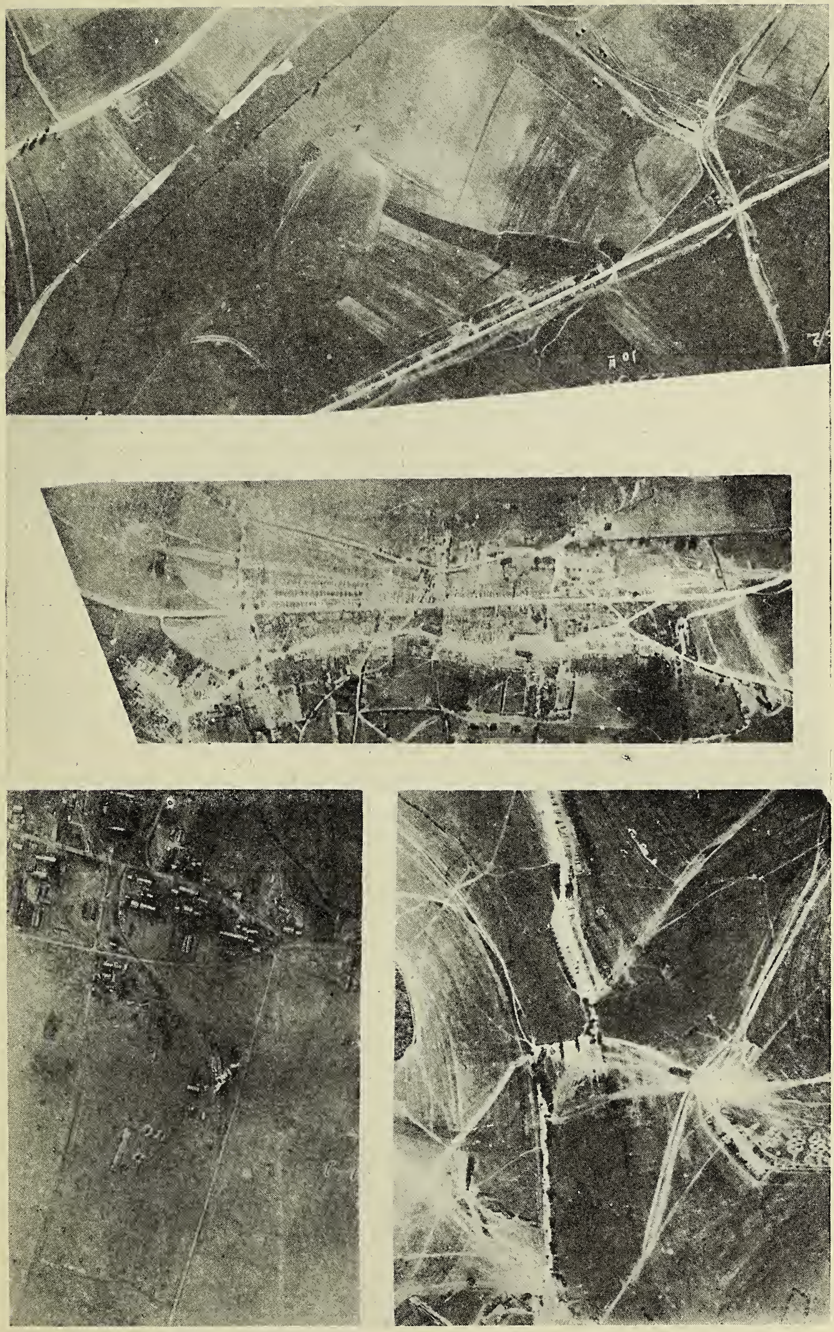
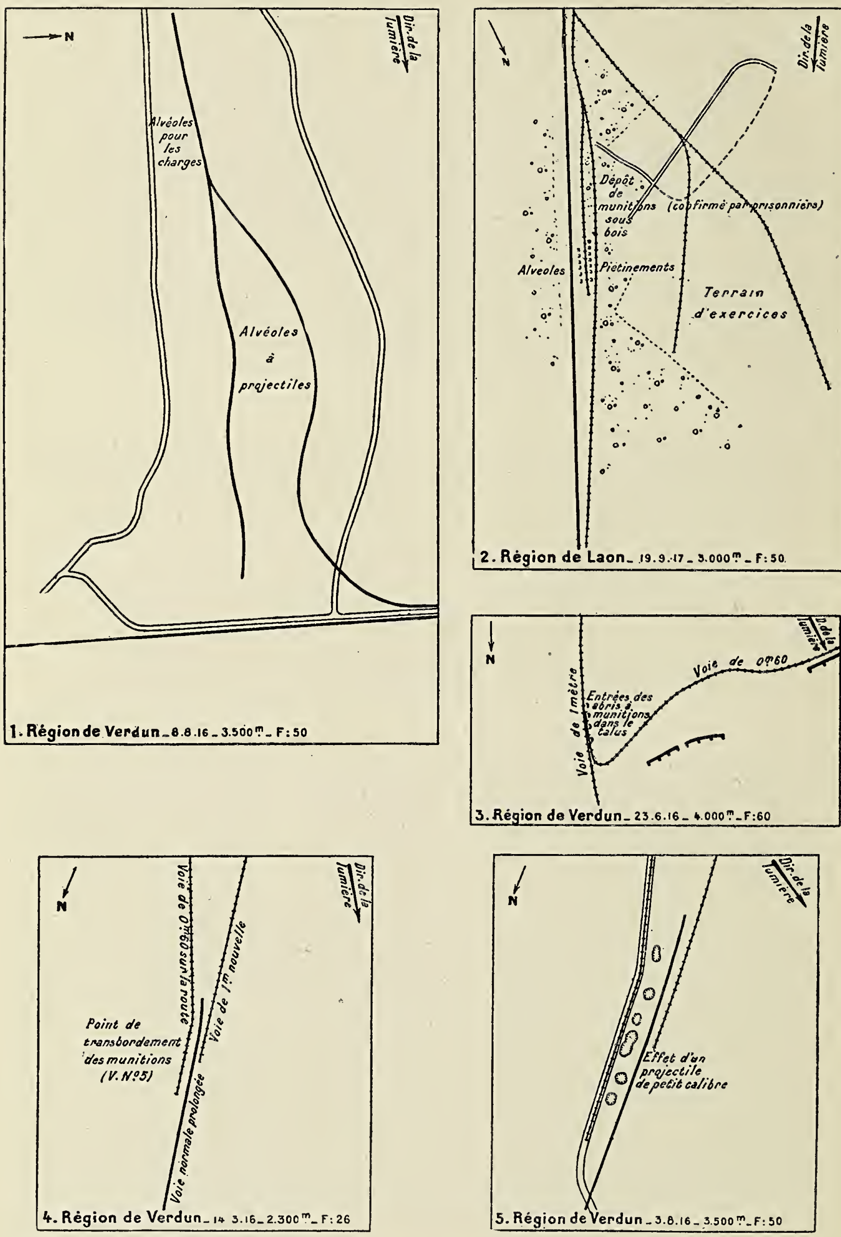


PLATE LV.—Ammunition depots (3).



1. Pits for charges.—Pits for projectiles.
2. Munition depot in woods (confirmed by prisoners).—Pits.—Trampled ground.—Drill ground.
3. One-meter railway.—0.6 meter railway.—Entrances to munition dugouts in bank.
4. Transfer point for munitions (see No. 5).—0.6 meter railway on highway.—Prolongation of standard-gauge railway.—New 1 meter railway.
5. Effect of small-caliber projectile.

PLATE LV.

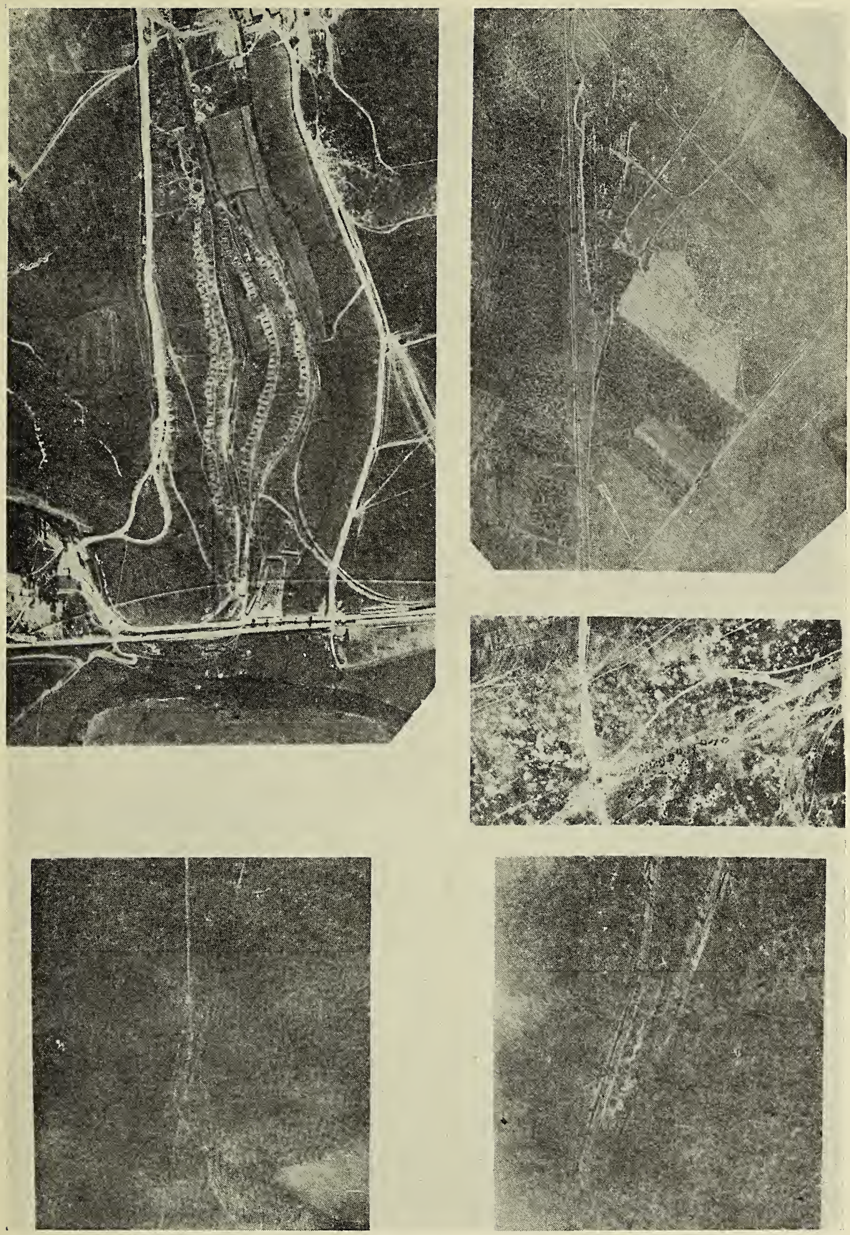
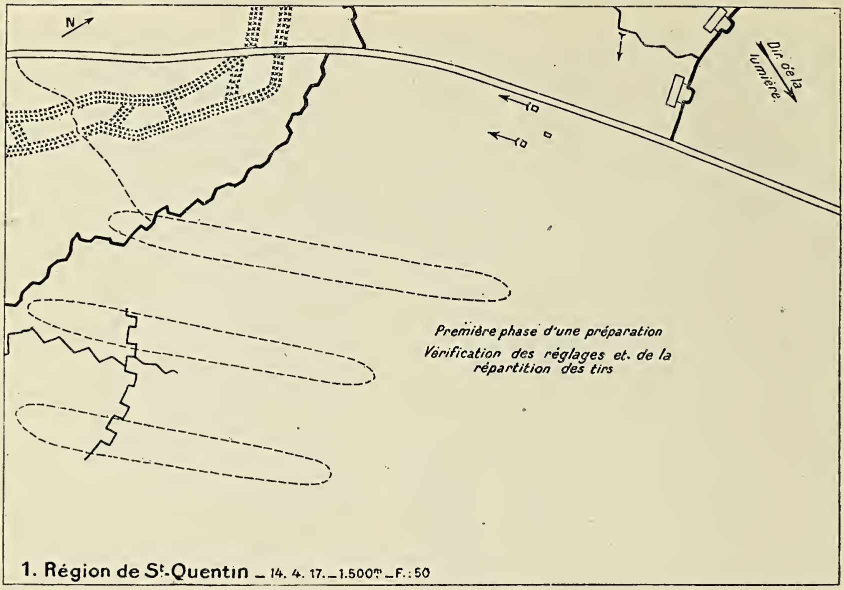
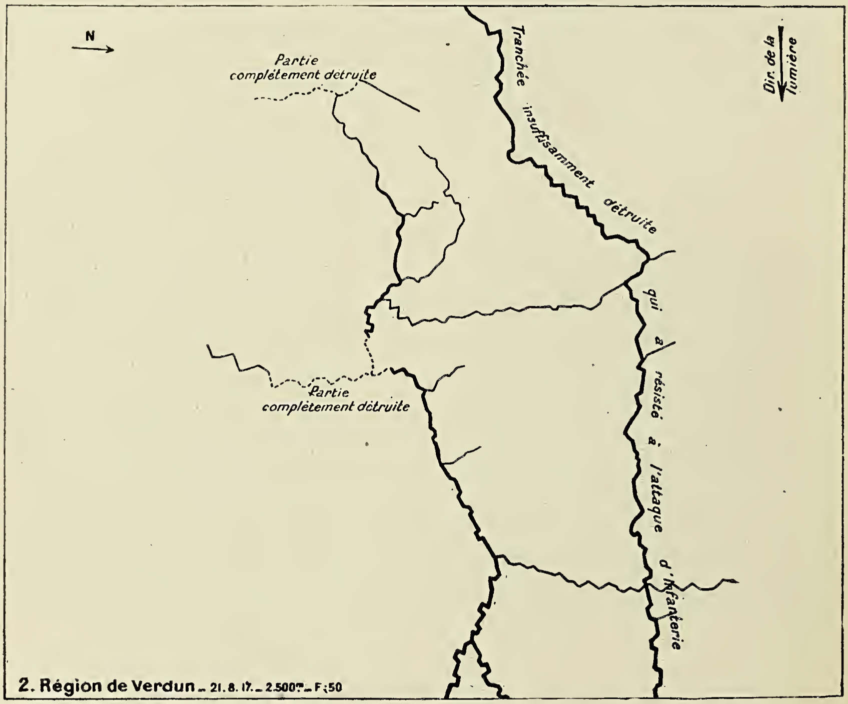


PLATE LVI.—Demolition of trenches, boyaus.





1. First phase of a preparation.—Verification of adjustments and of distribution of fire.
2. Part completely destroyed.—Trench not sufficiently demolished which resisted infantry attack.

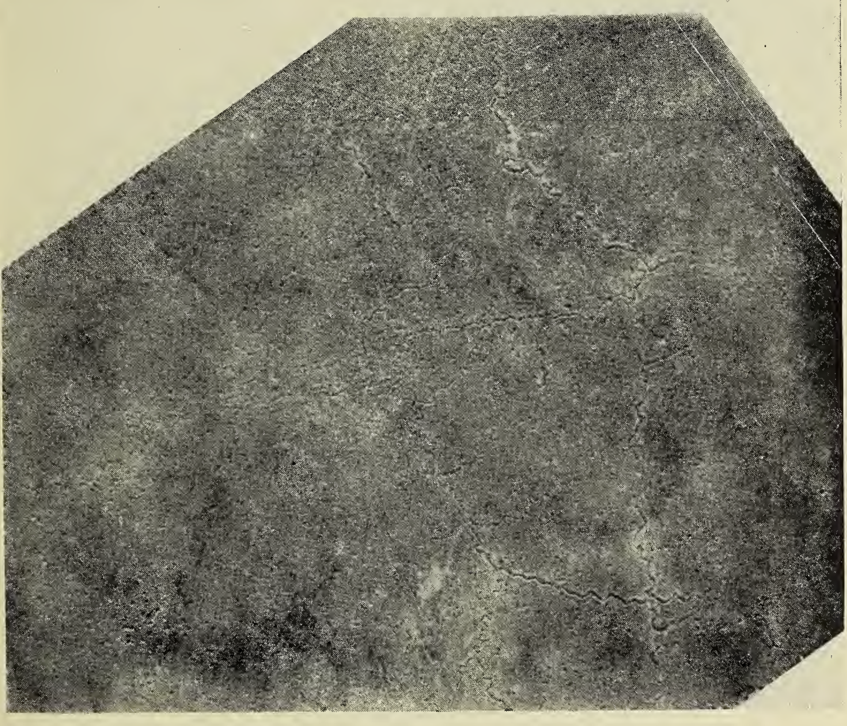
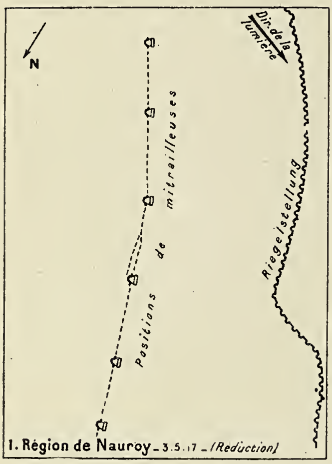
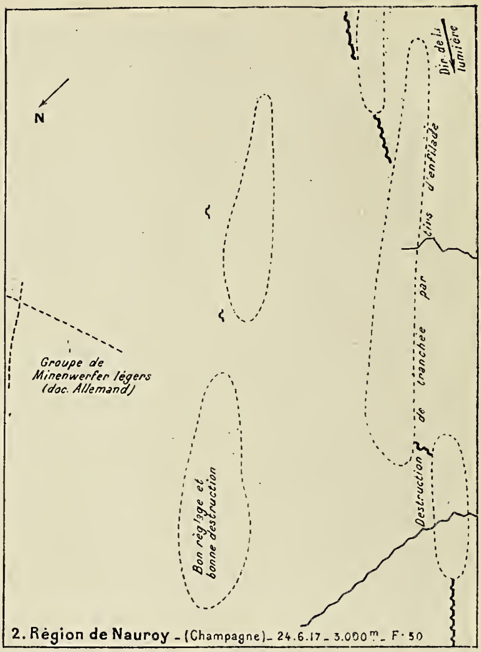
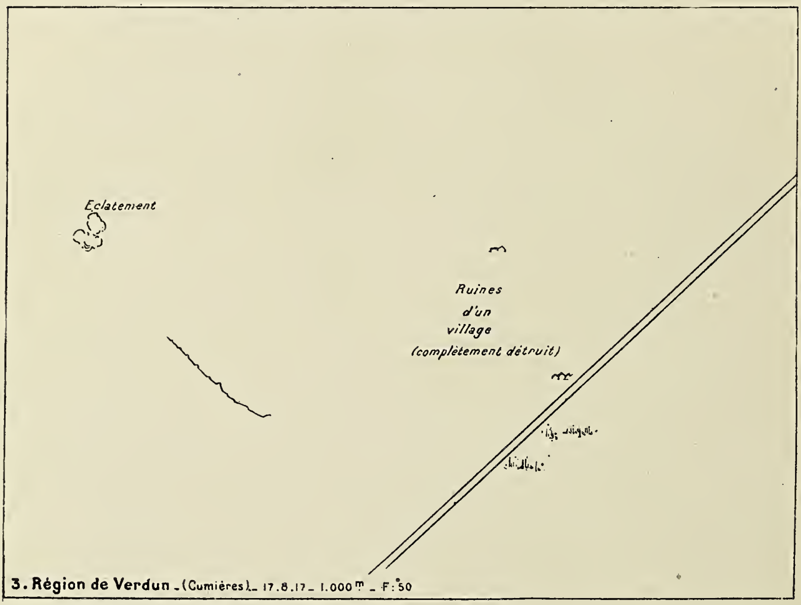


PLATE LVII.—Demolitions of machine-gun nests, of villages.







1. Machine gun emplacements.—Front line trench.
2. Group of light trench mortars.—Good artillery adjustment and good demolition.—Demolition of trench by enfilading fire.
3. Exploding shell.—Ruins of a village (completely destroyed).

PLATE LVII.

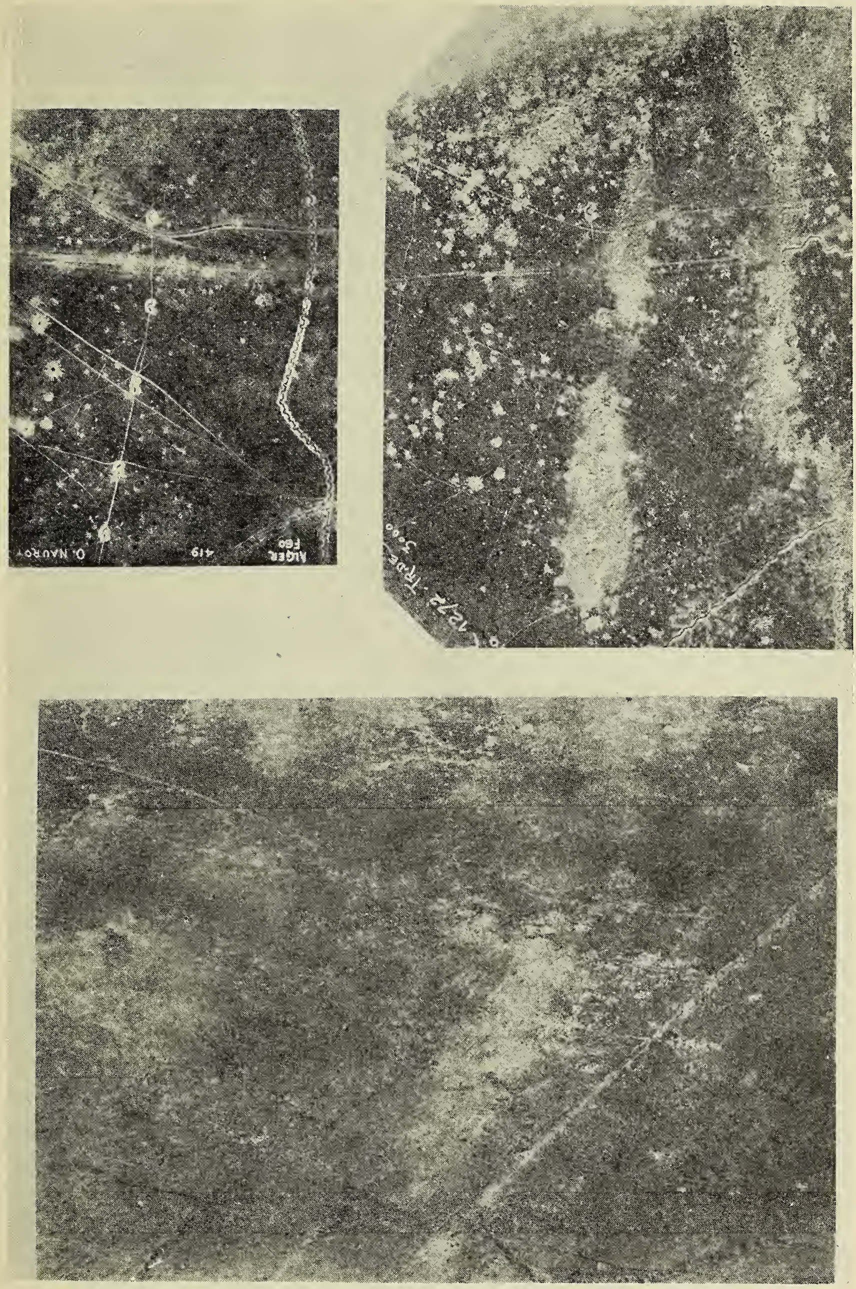
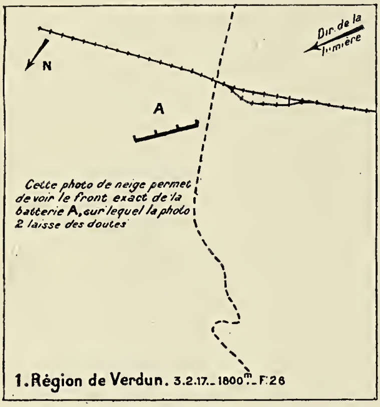
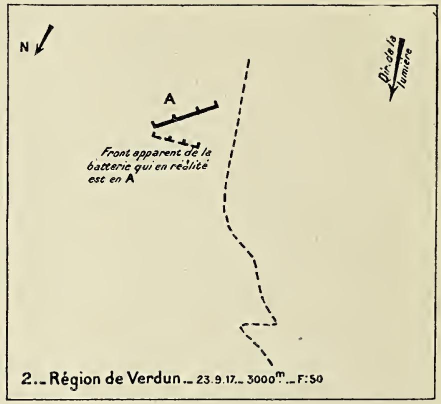


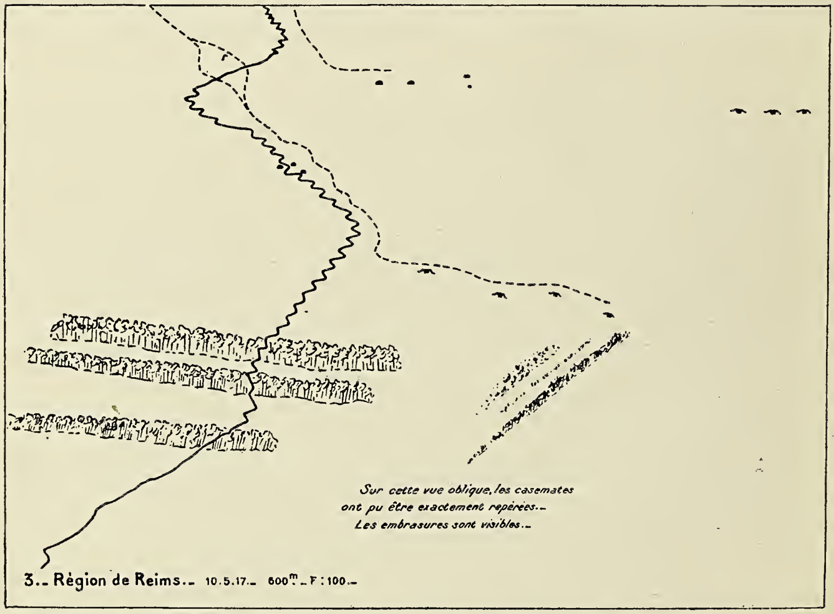
PLATE LVIII.—Demolitions of batteries (1).



1. Région de Verdun. 3.2.17.– 1800^{m}.– F:26



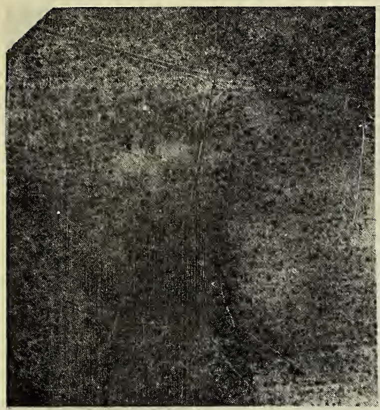
2.– Région de Verdun.– 23.9.17.– 3000^{m}.– F:50

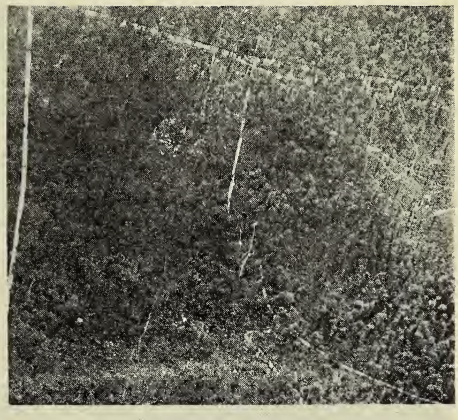


3.– Région de Reims.– 10.5.17.– 600^{m}.– F : 100.–

1. This snow photo shows exact front of battery A which photo No. 2 leaves in doubt.
2. Apparent front of battery which is really at A.
3. On this oblique view, the casemates have been exactly marked. The embrasures are visible.

PLATE LVIII.





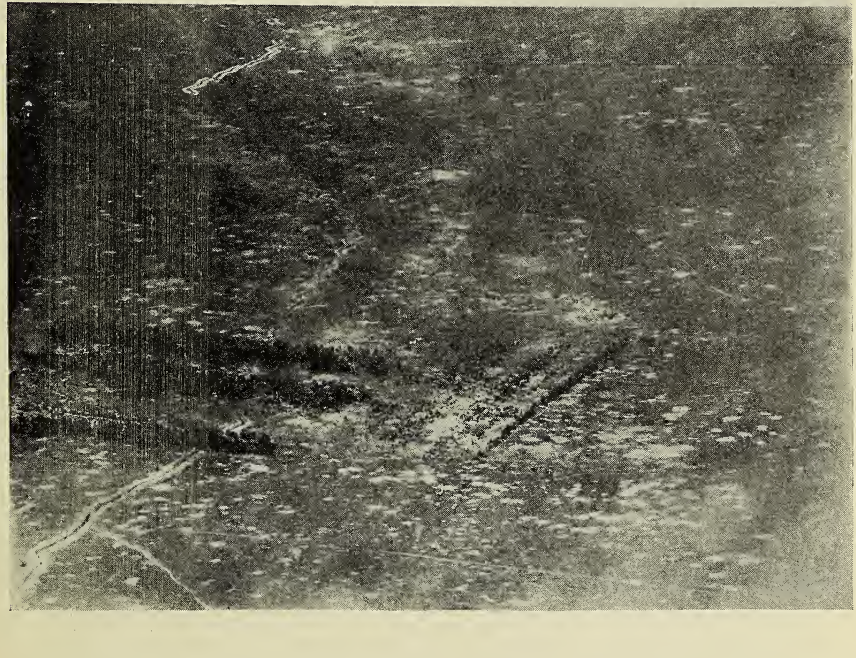
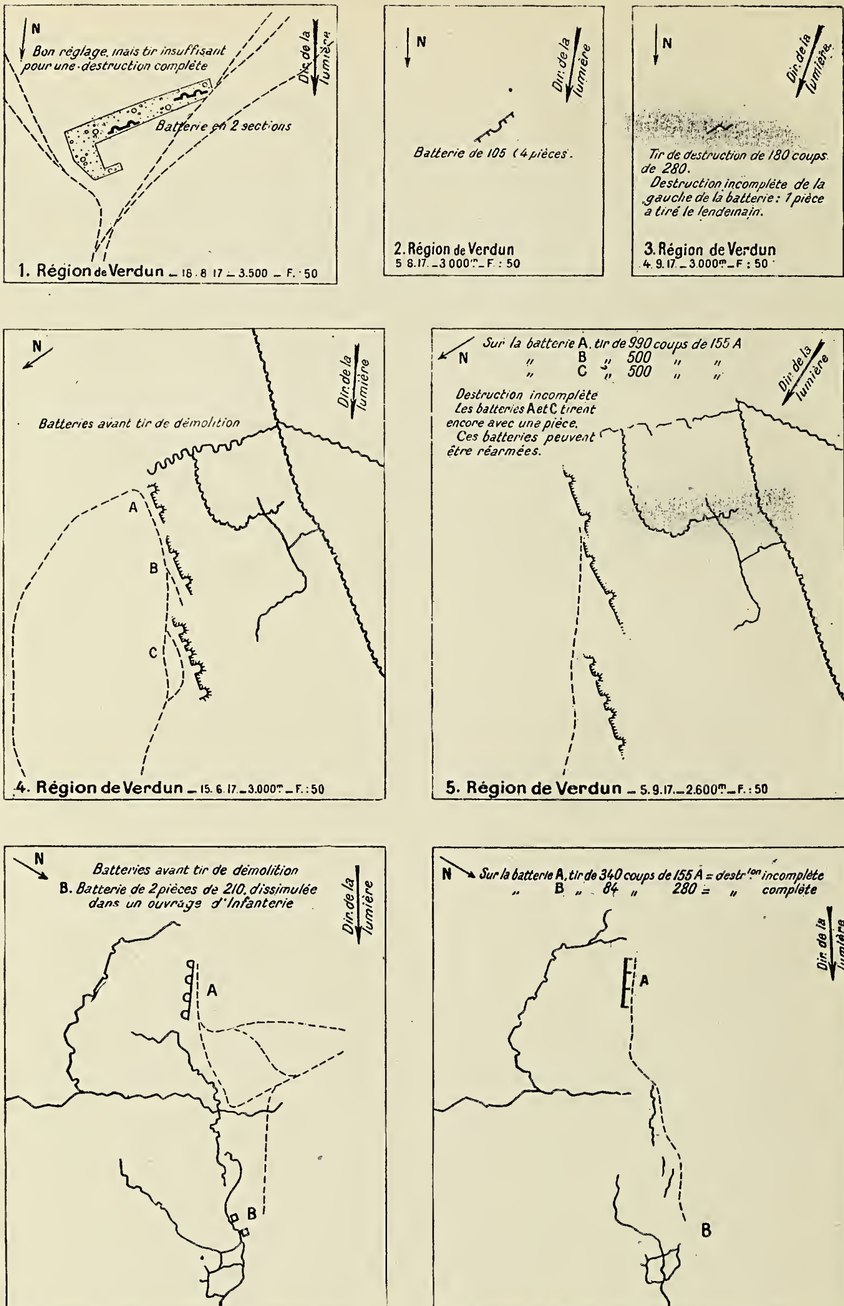


PLATE LIX.—Demolitions of batteries (2).



1. Good artillery adjustment, but firing insufficient for complete demolition.
2. 105 mm. battery (4 guns).
3. Demolition fire of 180 shots of 280 mm.—Demolition incomplete on left of battery. One gun fired next day.
4. Batteries before demolition firing.
5. On battery A, 900 shots of 155 mm. On battery B, 500 shots of 155 mm. On battery C, 500 shots of 155 mm. Demolition incomplete.—Batteries A and C fired again with one gun. These batteries can be set up again.
6. Batteries before demolition fire. B. Battery of two guns of 210 mm. concealed in infantry works.
7. On battery A, 340 shots of 155 mm. (demolition incomplete).—On battery B, 84 shots of 280 mm. (demolition complete).

PLATE LIX.

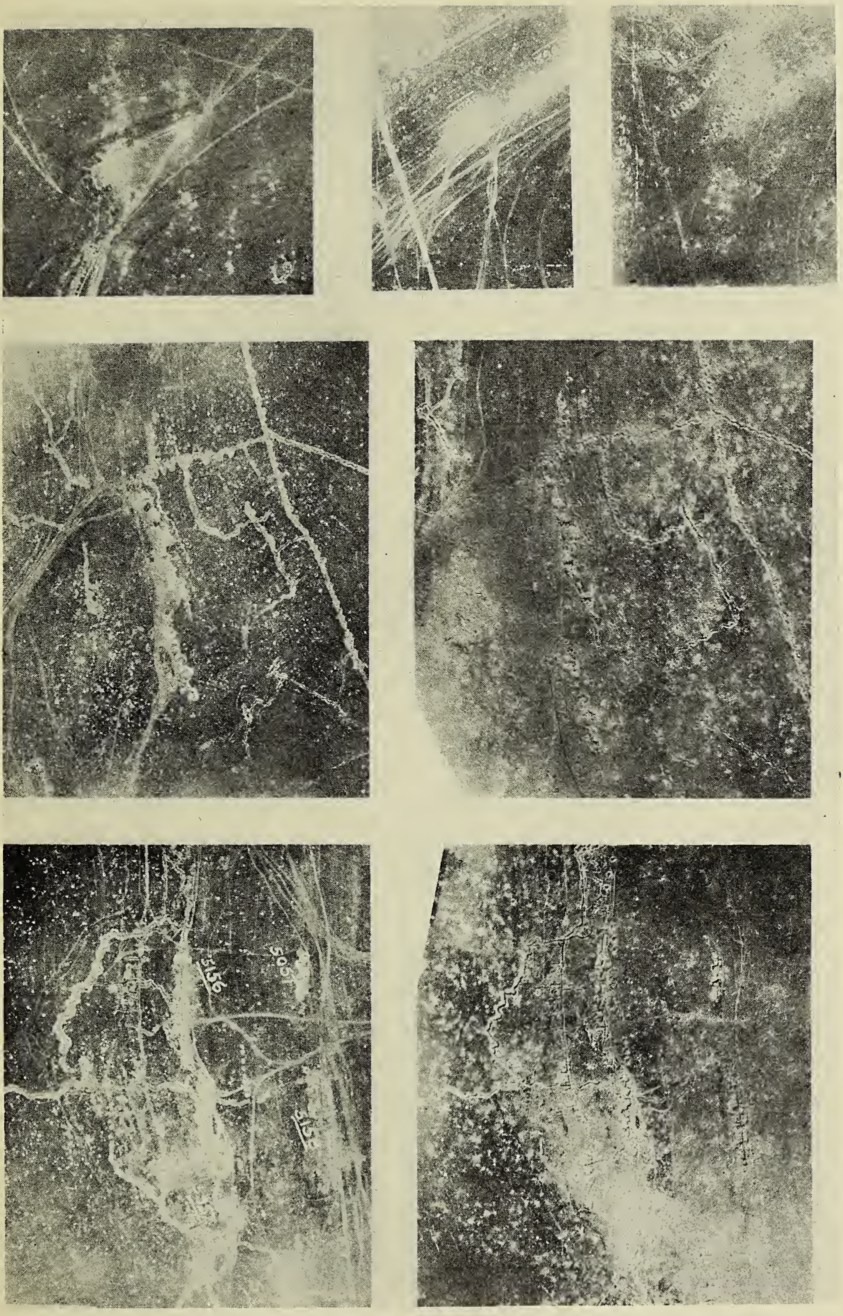
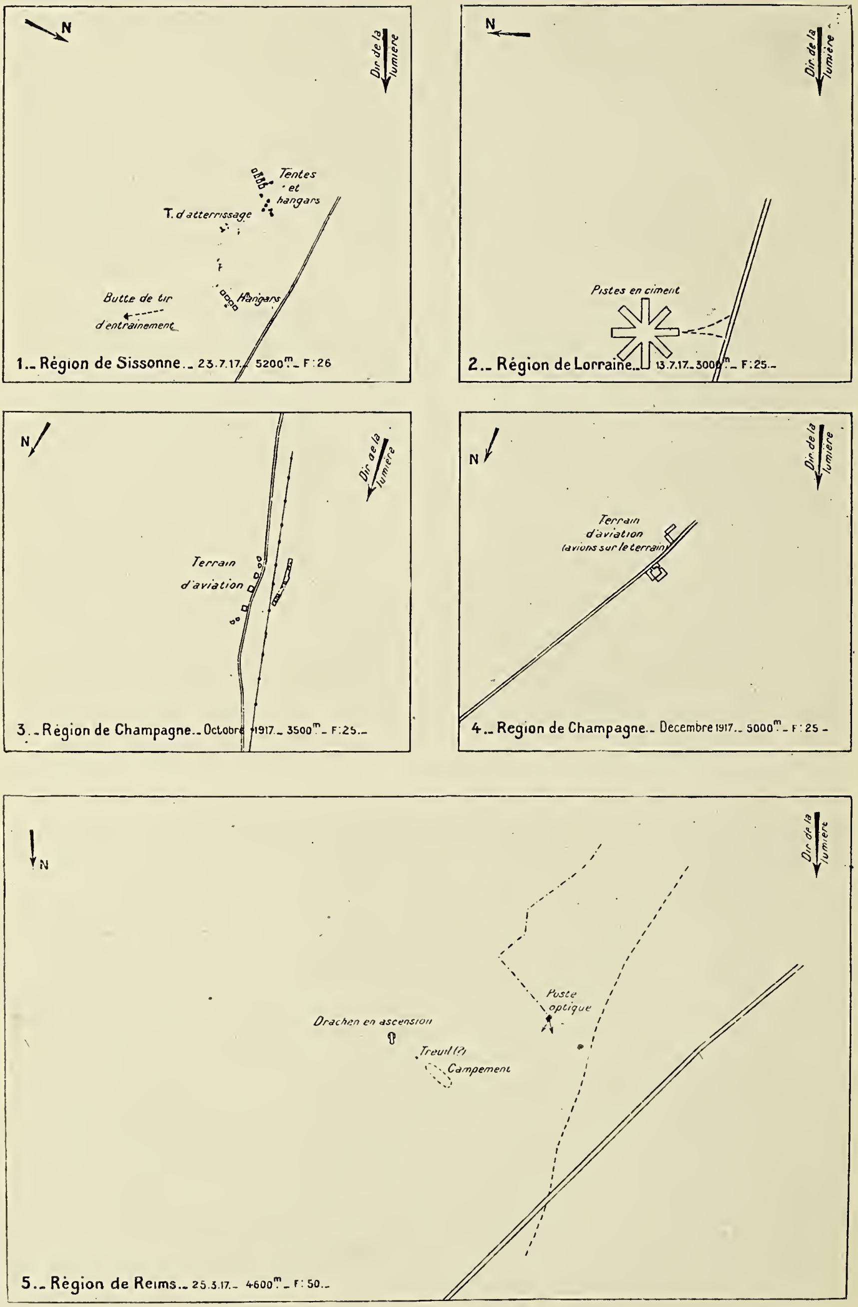
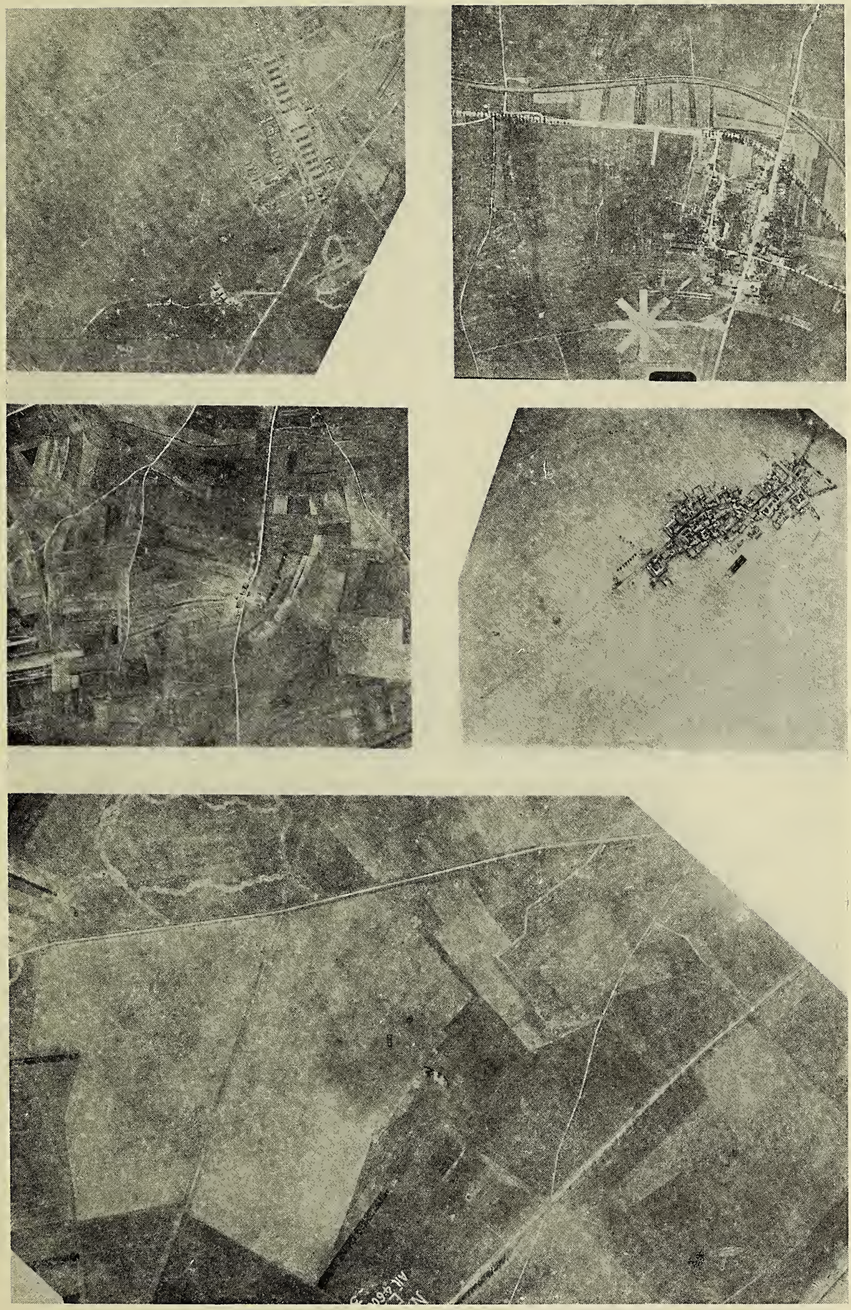


PLATE LX.—Aviation fields—Balloons.



1. Tents and hangars.—Landing T.—Target range for training.
2. Cement walks.
3. Aviation field.
4. Aviation field (airplanes on field).
5. Ascending Drachen (captive balloon).—Winch (z).—Camp.—Visual signalling station.

PLATE LX.



The Lowe Plauet Airship approaching Mount Lowe, over Pasadena and the San Gabriel Valley, California. The Lowe Observatory in foreground to the right.

The Latest Development in Aerial Navigation

Lowe Planet Airship

The Directors of the Pasadena Board of Trade, one of the largest and most representative professional and commercial bodies of the Pacific Coast, on March 7, 1910, unanimously passed the following resolution of endorsement of Professor Lowe and his Airship plans:

"We, the board of directors of the Pasadena board of trade, which comprises upward of 900 of the professional and business men of the city of Pasadena, Cal., in the interest and furtherance of science and the betterment of civilization, take pleasure in adding our unqualified endorsement and heartiest approval of the plans and devices of Prof. T. S. C. Lowe as incorporated in the Lowe Planet Airship.

We believe that the principles involved in its construction and operation are purely scientific, simple, and practical; and confidently anticipate a realization of all that the inventor claims for his airship as a future carrier of freight and passengers as well as a most significant, if not the controlling factor in warfare, both by land and sea. These considerations make this new method of locomotion a claimant for the serious attention of the entire world, involving, as it does, questions of infinite importance to every nation and community on earth, and it would seem that the limitless field of applied science is destined soon to realize as far reaching a development in the art of air navigation as has resulted from the application of steam to water and land locomotion or from the almost infinite number and variety of applications of electricity to every department of human activity. The atmosphere is not only a free, but a boundless medium of locomotion, and any thoroughly intelligent attempt to reduce its magnificent possibilities to the every day commercial and aesthetic needs of the human race ought to have the profoundest sympathy and the active cooperation of all who are interested in the progress of civilization and the uplift of humanity.

The Directors of the Pasadena Board of Trade,

E. T. Off, President.

A. J. Bertonneau, Secretary.

INTRODUCTORY

The era of practical aeronautics is at hand. The stage of experimentation has passed. There is already an active demand for air craft of demonstrable utility and the world is ready to accord honor, fame and wealth to the inventor who first places in the field an airship that demonstrates: Its practical safety; Its dirigibility and easy handling; Its ability to transport passengers with comfort; and Its capacity to carry heavy freight.

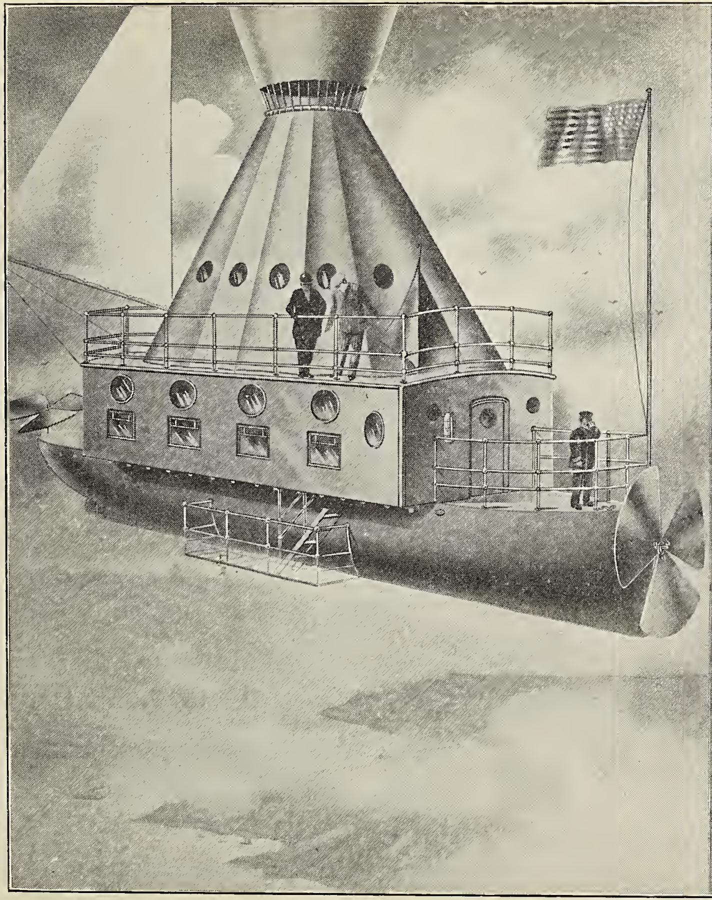
In the following pages it will be shown that all these conditions are more than met in the LOWE PLANET AIRSHIP.

The aircraft of the type and size herein considered will transport twenty to fifty passengers, with as luxurious comfort and safety as a Pullman Car or transatlantic steamer. And who that has not experienced it can conceive the delights of noiselessly, smoothly and swiftly navigating the air, overlooking all the varied scenery of the earth's surface and gazing down with an all-embracing sweep of vision upon the land operations of the human beings below! To ascend as a bird into the upper atmosphere and there travel unrestrainedly to and fro, has ever been one of the apparently unattainable ambitions of the most exalted minds of the human race, but now, by means of this Planet Airship, this last great conquest by man's genius is made possible. Through his steam engines and automobiles, man has annihilated space on land; by his steamers he has conquered the forces of nature on the water, and moves in safety from continent to continent over the trackless wastes of the expansive oceans; and now, by means of the Lowe Planet Airship, the last element open to him—the atmosphere—is to be invaded and the easier, more luxurious, delightful and scenic method of transportation is to be under his control.

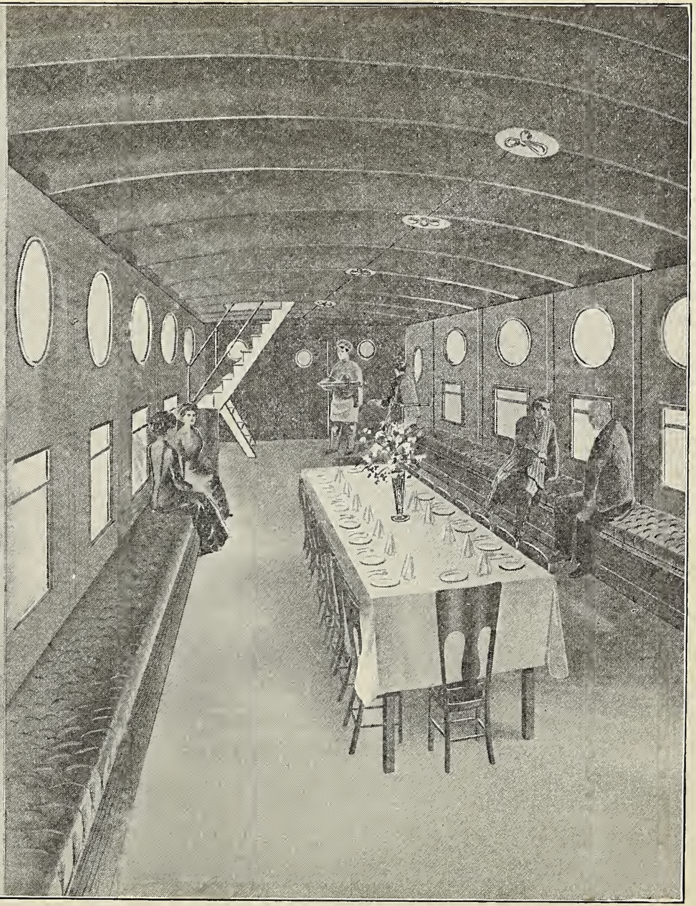
That this is no chimera, Professor Lowe's past achievements make certain, and it is to a rapid survey of these that this booklet is devoted. After a full and detailed description of the Lowe Planet Airship, a history of Professor Lowe's actual achievements in aeronautics, both before, during and after the civil war, is given, with the personal comments made upon them at the time by men of national and international reputation as soldiers, scientists and statesmen.

That the Lowe Planet Airship is the next great movement in aerial navigation, and therefore offers the best financial investment in the world, will not be doubted after a careful perusal of the following pages.

AERIAL PUBLISHING COMPANY,
522 Central Building,
Los Angeles, Cal.



Perspective View of Power Launch, Passenger Cabin, and Navigating Room of Planet Airship



Interior of Passenger Cabin, Lowe Planet Airship

THE LOWE PLANET AIRSHIP

The Lowe Planet Airship is no experiment. It asks for no indulgence on the ground of uncertainty, but is ready to be judged by all intelligent minds upon the showing herein made of practical experiences of many years, under the severest tests that the forces of nature could bring or the ingenuity of man devise. Every claim made for it *has already been demonstrated*, and its success is as certain as that of any improved type of steam engine or automobile, based upon principles already established and in practical use.

A TWENTY-TWO TON AIRSHIP FIFTY YEARS AGO

Fifty years ago Professor Lowe, constructed an airship, capable of lifting *twenty-two tons*, and a full account is later given from the graphic pen of the accomplished Garrick Mallery of a trip he and others made in that greatest of all airships. But in those days there was no engine invented that could be used for propelling an aircraft, therefore, the only method of travel was by an observance of the air currents and floating with them.

SUITABLE ENGINE REQUIRED

It was soon evident, therefore, to Professor Lowe, that before aerial navigation could be brought to perfection, it was essential that a light, reliable and high-power engine should be invented and developed to a high degree. This has recently been accomplished in the automobile engine, which has demonstrated its utility under every kind of severest practical test.

DANGEROUS TYPES OF DIRIGIBLES

With this perfected engine to aid them, several investigators and experimenters have constructed more or less dangerous types of airships, such as the French "Republic," Lebaudy's "Patrie," Count de la Vaulx's and Deutsch's "Ville de Paris," and the more extensive and well-known German Zeppelin types. The cigar-shape, however, which has been assumed by all these experimenters, has been proven to be impracticable for several reasons. The shape itself demands a strong framework to hold it rigid for the suspension of the car, and this adds materially to its weight, while at the same time it offers two and a half times more surface against adverse wind currents than a semi-spherical envelope of the same relative size.

THE SPECTACULAR ZEPPELIN TYPE

It cannot be denied, however, that the Zeppelin type of airship is more spectacular than any other yet presented, and possibly that is one reason why so much time, money and inventive genius have been expended in trying to make it practical. Yet its small lifting capacity beyond its

own weight, and the utter impossibility of transporting it on land or water by ordinary methods altogether precludes the possibility of its coming into general use. Indeed, the German government has already declined to consider it further for either naval or military purposes.

A PERFECTLY SAFE TYPE

The Lowe Planet Airship has avoided all the difficulties and dangers encountered by these late investigators, at the same time utilizing the automobile engine that renders it propulsive and completely amenable to guidance. This airship is composed of two portions, inseparably connected, yet which should be considered separately. These are, I. The envelope or holder of buoyant gas for sustaining the car. II. The passenger car.

I. THE ENVELOPE OR GAS HOLDER

After years of personal experience and a thorough study of the experiments of others, Professor Lowe has demonstrated that the globular form is the only safe and practical method of airship construction. It requires no framework to support its shape, presents the least surface to aerial currents in proportion to its carrying capacity and is in no danger of tilting, experience having demonstrated that it always strives to remain vertical over the weight it carries, and thus is practically rigid.

The hydrogen holder is made of strong, heavy silk, and covered with an impervious preparation invented by Professor Lowe (a secret process) which not only prevents the gas from escaping, or injuring the silk but renders the envelope unaffected by weather. Thus, while ordinary balloons lose their contents by leakage in a few days, Professor Lowe's war balloons retained their contents for months, though subjected to the rain, snow, sleet and blasts of wintry weather, as well as the heat and dry wind of the summer.

This gas envelope is covered with a strong network of specially made linen or silk cords. These cords are united at the bottom and then attached with scientific skill and care to the passenger car below.

THE EXPANSION CONE

A distinctively individualistic feature of the Lowe Planet Airship is the "Expansion Cone." To properly understand the use of this cone it is necessary to recall the fact that the ordinary balloon ascends under one of two conditions, one of which is exceedingly wasteful and the other is adverse to rigidity. Under the first condition the balloon is completely filled with gas, and thus, when it ascends into the higher altitudes, and the gas expands, it is necessary to open the valve and allow the expanded gas to escape. Gas thus released is forever lost, and the lifting power correspondingly reduced. Under the second condition the balloon is only

partially filled, and thus, loose and flabby at its lower extremity, is tossed to and fro by every diverse current while anchored, and assumes rigidity only when the gas expands in the higher altitudes.

By means of the Expansion Cone in the Lowe Planet Airship, room is afforded for both the expansion and contraction of the gas, within its protected space. Consequently, it will be seen that even before ascension (as well as afterwards) rigidity is maintained without any escape of gas or loss of lifting power.

EXPANSION AND CONTRACTION PROVIDED FOR

To further regulate the expansion and contraction of the gas, due to differing temperatures of the outside atmosphere, the Lowe Airship is provided with scientific appliances which keep the hydrogen within the envelope at an even temperature, both night and day. These appliances are exceedingly simple, and work almost automatically, requiring but little attention.

HYDROGEN GAS

To appreciate the lifting power of hydrogen it is necessary to refer to some interesting figures.

One thousand cubic feet of the air we breathe weighs 76.6 pounds, while 1,000 cubic feet of hydrogen gas, occupying the same space or bulk, weighs only 5.3 pounds. The air, then, weighs 14.4 times as much as hydrogen. Thus every 1,000 feet of confined hydrogen gas has a lifting power of 71 pounds.

The following table shows the lifting power of hydrogen-filled holders of varying dimensions:

Diameter	Surface	Gas Holding Capacity	Buoyancy or Lifting Capacity	Tons
3 Ft.	2,827 Sq. Ft.	14,137 Cub. Ft	848 lbs.	0.42
40	5,026	33,510	2,010	1.00
50	7,854	65,450	3,927	1.96
60	1 ,310	113,098	6,785	3.39
80	20,106	268,083	16,085	8.04
100	31,416	523,508	31,410	15.70
125	49,088	1,022,656	61,359	30.07
150	70,688	1,766,972	106,018	53.00
200	125,664	4,188,792	251,327	125.66
250	196,352	8,181,248	490,874	245.43
300	282,752	14,135,376	848,122	424.06
400	502,656	33,510,336	2,094,400	1,047.20
800	2,010,624	268,082,688	16,755,200	8,377.60

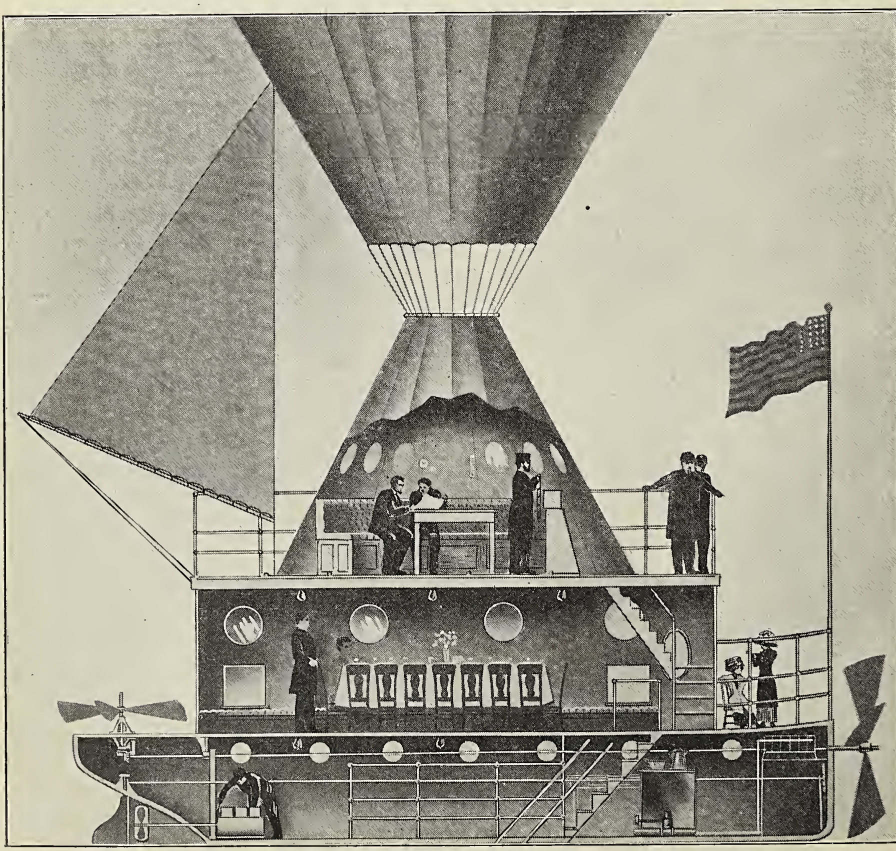
It will thus be seen that a hydrogen holder 150 feet in diameter is capable of sustaining a weight of fifty-three tons, about five times the weight of a passenger car for forty persons, equipped with the necessary engines and fuel, and provided with abundant food supplies, and all else needed for comfort and enjoyment.

EASILY PACKED AND TRANSPORTED

Another great advantage possessed by this form of airship is that although while being propelled in the atmosphere it is rigid, it becomes most convenient and compressible when it is desired to pack it for transportation on land or water, so that a score or more of them could easily be packed and transported upon an ordinary sea-going yacht. The value of this feature cannot be overestimated.

II. THE PASSENGER CAR

This is a well equipped power-launch, with all the usual accommodations for passengers, provisions and freight. Above it a roomy, comfortable cabin is provided, built in sections so that it can be "knocked down" and packed in the launch should its transportation be desired. This cabin is used as dining room, observation or sleeping car as required, in addition to the other accommodations. Over this cabin is a collapsible room of generous dimensions for the use of the navigators, observers, photographers, etc. It is provided with all the necessary instruments, as barometers, telescopes, field glasses, thermometers, sextants, altimeters, etc.



Sectional View of Interior of Power Launch, Passenger Cabin and Navigating Room of Planet Airship

Every room is lighted with electric light, and heated, when required, with the exhaust from the engines, which also gives the necessary heat for cooking purposes. In fact, every comfort and luxury has been thought of, exactly as in a modern hotel, Pullman car, or first-class steamship. Wireless telegraph apparatus is suspended from the power launch, thus affording instant and constant communication with the earth.

Being thus equipped for long voyages it is never necessary for the Planet Airship to land in a storm. If the weather is unpropitious it can ascend by means of its vertical propeller above all storms and remain there until the weather is suitable for landing.

PROPELLERS

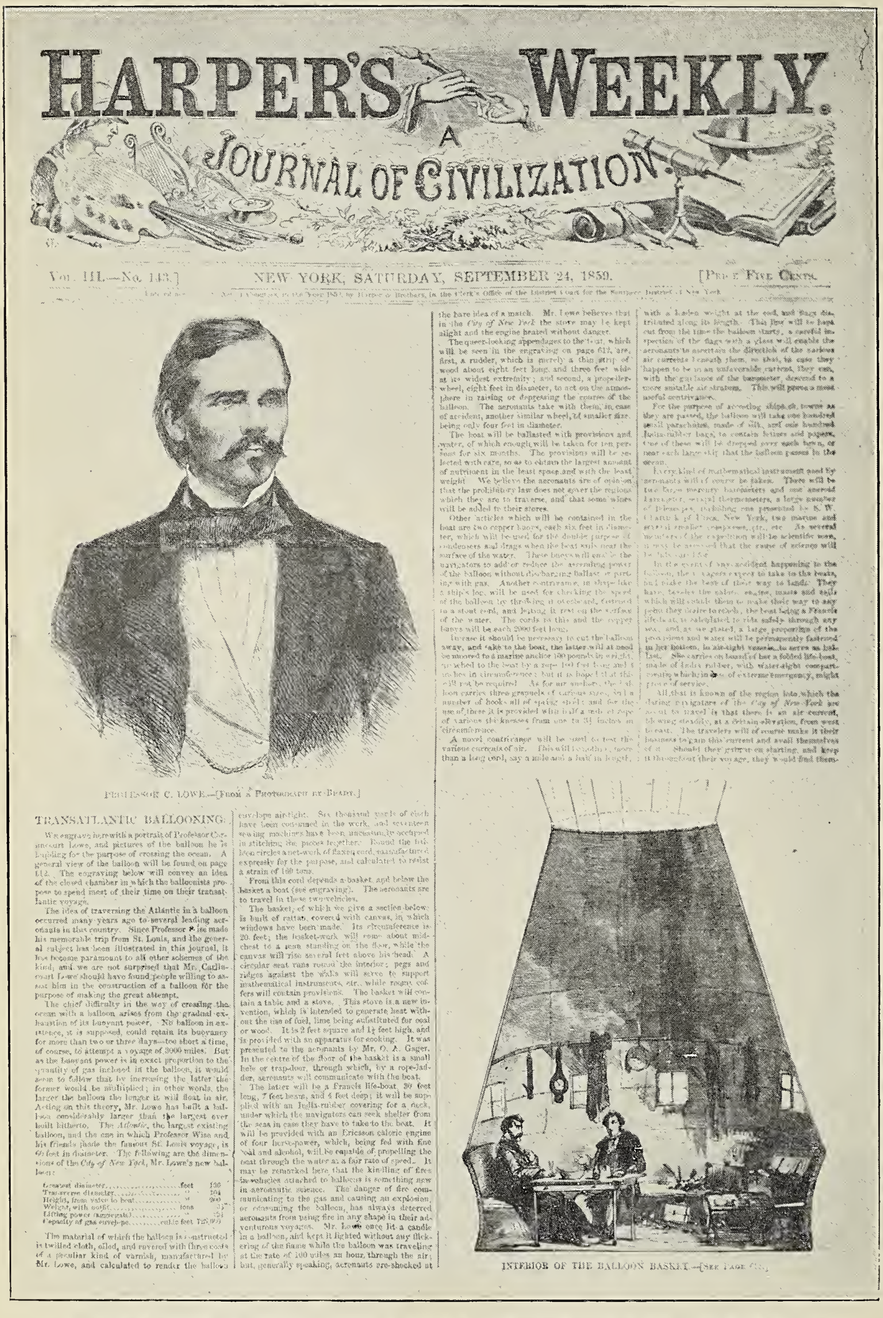
Two propellers of suitable power are provided, one each for vertical and horizontal propulsion. The former is located on the bow or stern of the power-launch, and is used to raise or lower the airship into the various surface and upper currents, so as to add their speed to that obtained by the power of the horizontal propeller. This latter is the chief motive power and is the finest model known to mechanics, and of the highest efficiency. Each propeller has its own gasoline engine, and the gearings are so arranged that in case of necessity, either can operate the other. A fully equipped repair shop is provided on board.

ANCHORS AND ANCHORAGE PLACES

Both land and water anchors are added to the equipment of sufficient strength to aid in landing when found necessary, though as a rule the airship is propelled by its own power to any point desired, the same as a steamship to its harbor and wharf. As these airships come into general use each city will provide its own anchorage place, free from obstructions, (as a ship's wharf is provided), where they can arrive and depart at pleasure. Unlike the one- or two-passenger aeroplanes that require acres of ground from which to make a safe rise, or landing, a giant airship capable of carrying fifty or a hundred passengers can be safely accommodated on less than an acre of ground.

BUILT UPON EXPERIENCE

From the foregoing details, therefore, it will readily be seen that the main principles upon which the construction of the Lowe Planet Airship depends are as well known and tested as are those of the steamship, the railway engine and the automobile, while the *methods of application* of these principles are novel, personal and unique to this particular type of aircraft. Every possibility has been provided for, every event foreseen, the thousands of ascensions made by Professor Lowe before, during and after the civil war, in winter and summer, during the heat of the summer's day, in the darkness of night, even during thunder-storms, having given him a knowledge that could not be gained in any other way. Hence, the promoters of the Lowe Planet Airship confidently affirm the immense superiority of their aircraft over that of any other type, in principles and details of construction, lifting capacity, easy control, comfort and safety of passengers, and general efficiency.



HARPER'S WEEKLY.

A JOURNAL OF CIVILIZATION.

Vol. III.—No. 143.] NEW YORK, SATURDAY, SEPTEMBER 24, 1859. [Price Five Cents.

PROFESSOR C. LOWE.—[From a Photograph by Brady.]

TRANSATLANTIC BALLOONING.

We engrave herewith a portrait of Professor Thaddeus Lowe, and pictures of the balloon he is building for the purpose of crossing the ocean. A general view of the balloon will be found on page 612. The engraving below will convey an idea of the closed chamber in which the balloonists propose to spend most of their time on their transatlantic voyage.

The idea of traversing the Atlantic in a balloon occurred many years ago to several leading aeronauts in this country. Since Professor Wise made his memorable trip from St. Louis, and the general subject has been illustrated in this journal, it has become paramount to all other schemes of the kind; and we are not surprised that Mr. Carlincourt Lowe should have found people willing to assist him in the construction of a balloon for the purpose of making the great attempt.

The chief difficulty in the way of crossing the ocean with a balloon arises from the gradual exhaustion of its buoyant power. No balloon in existence, it is supposed, could retain its buoyancy for more than two or three days—too short a time, of course, to attempt a voyage of 3000 miles. But as the buoyant power is in exact proportion to the quantity of gas inclosed in the balloon, it would seem to follow that by increasing the latter the former would be multiplied; in other words, the larger the balloon the longer it will float in air. Acting on this theory, Mr. Lowe has built a balloon considerably larger than the largest ever built hitherto. The *Atlantic*, the largest existing balloon, and the one in which Professor Wise and his friends made the famous St. Louis voyage, is 60 feet in diameter. The following are the dimensions of the *City of New York*, Mr. Lowe's new balloon:

Greatest diameter	feet	130
Transverse diameter	"	104
Height, from valve to boat	"	200
Weight, with outfit	tons	[illegible]
Lifting power (aggregate)	"	[illegible]
Capacity of gas envelope	cubic feet	725,000

The material of which the balloon is constructed is twilled cloth, oiled, and covered with three coats of a peculiar kind of varnish, manufactured by Mr. Lowe, and calculated to render the balloon envelope air-tight. Six thousand yards of cloth have been consumed in the work, and seventeen sewing machines have been incessantly occupied in stitching the pieces together. Round the balloon circles a net-work of flaxen cord, manufactured expressly for the purpose, and calculated to resist a strain of 160 tons.

From this cord depends a basket, and below the basket a boat (see engraving). The aeronauts are to travel in these two vehicles.

The basket, of which we give a section below, is built of rattan, covered with canvas, in which windows have been made. Its circumference is 20 feet; the basket-work will come about mid-chest to a man standing on the floor, while the canvas will rise several feet above his head. A circular seat runs round the interior; pegs and ridges against the walls will serve to support mathematical instruments, etc., while roomy coffers will contain provisions. The basket will contain a table and a stove. This stove is a new invention, which is intended to generate heat without the use of fuel, lime being substituted for coal or wood. It is 2 feet square and 1½ feet high, and is provided with an apparatus for cooking. It was presented to the aeronauts by Mr. O. A. Gager. In the centre of the floor of the basket is a small hole or trap-door, through which, by a rope-ladder, aeronauts will communicate with the boat.

The latter will be a Francis life-boat, 30 feet long, 7 feet beam, and 4 feet deep; it will be supplied with an India-rubber covering for a deck, under which the navigators can seek shelter from the seas in case they have to take to the boat. It will be provided with an Ericsson caloric engine of four horse-power, which, being fed with fine coal and alcohol, will be capable of propelling the boat through the water at a fair rate of speed. It may be remarked here that the kindling of fires in vehicles attached to balloons is something new in aeronautic science. The danger of fire communicating to the gas and causing an explosion, or consuming the balloon, has always deterred aeronauts from using fire in any shape in their adventurous voyages. Mr. Lowe once lit a candle in a balloon, and kept it lighted without any flickering of the flame while the balloon was traveling at the rate of 100 miles an hour through the air; but, generally speaking, aeronauts are shocked at the bare idea of a match. Mr. Lowe believes that in the *City of New York* the stove may be kept alight and the engine heated without danger.

The queer-looking appendages to the boat, which will be seen in the engraving on page 612, are, first, a rudder, which is merely a thin strip of wood about eight feet long and three feet wide at its widest extremity; and second, a propeller-wheel, eight feet in diameter, to act on the atmosphere in raising or depressing the course of the balloon. The aeronauts take with them, in case of accident, another similar wheel, of smaller size, being only four feet in diameter.

The boat will be ballasted with provisions and water, of which enough will be taken for ten persons for six months. The provisions will be selected with care, so as to obtain the largest amount of nutriment in the least space and with the least weight. We believe the aeronauts are of opinion that the prohibitory law does not cover the regions which they are to traverse, and that some wines will be added to their stores.

Other articles which will be contained in the boat are two copper buoys, each six feet in diameter, which will be used for the double purpose of condensers and drags when the boat sails near the surface of the water. These buoys will enable the navigators to add or reduce the ascending power of the balloon without discharging ballast or parting with gas. Another contrivance, in shape like a ship's log, will be used for checking the speed of the balloon by throwing it overboard, fastened to a stout cord, and letting it rest on the surface of the water. The cords to this and the copper buoys will be each 2000 feet long.

In case it should be necessary to cut the balloon away, and take to the boat, the latter will at need be moored to a marine anchor 100 pounds in weight, attached to the boat by a rope 100 feet long and 4 inches in circumference; but it is hoped that this will not be required. As for air anchors, the balloon carries three grapnels of various sizes, and a number of hooks all of spring steel; and for the use of these it is provided with half a mile of rope of various thicknesses from one to 3½ inches in circumference.

A novel contrivance will be used to test the various currents of air. This will be nothing more than a long cord, say a mile and a half in length, with a leaden weight at the end, and flags distributed along its length. This line will be kept out from the time the balloon starts; a careful inspection of the flags with a glass will enable the aeronauts to ascertain the direction of the various air currents beneath them, so that, in case they happen to be in an unfavorable current, they can, with the guidance of the barometer, descend to a more suitable air stratum. This will prove a most useful contrivance.

For the purpose of reporting ships, etc., towns as they are passed, the balloon will take one hundred small parachutes, made of silk, and one hundred India-rubber bags, to contain letters and papers. One of these will be dropped over each town, or near each large ship that the balloon passes in the ocean.

Every kind of mathematical instrument used by aeronauts will of course be taken. There will be two large mercury barometers and one aneroid barometer, several thermometers, a large number of telescopes, including one presented by S. W. [illegible] of Utica, New York, two marine and several smaller compasses, etc., etc. As several members of the expedition will be scientific men, it may be assumed that the cause of science will be [illegible].

In the event of any accident happening to the balloon, the voyagers expect to take to the boat, and make the best of their way to land. They have, besides the caloric engine, masts and sails which will enable them to make their way to any point they desire to reach, the boat being a Francis life-boat, is calculated to ride safely through any sea, and, as we stated, a large proportion of the provisions and water will be permanently fastened in her bottom, in air-tight vessels, to serve as ballast. She carries on board of her a folded life-boat, made of India rubber, with water-tight compartments, which in case of extreme emergency, might prove of service.

All that is known of the region into which the daring navigators of the *City of New York* are about to travel is that there is an air current, blowing steadily, at a certain elevation, from west to east. The travelers will of course make it their business to gain this current and avail themselves of it. Should they gain it on starting, and keep it throughout their voyage, they would find them-

INTERIOR OF THE BALLOON BASKET.—[See Page 6[illegible].]

Page of Harper's Weekly, Showing Portrait of Professor Lowe at the Age of 27 Years and Interior of Airship Car

WHAT CAN BE DONE WITH THE LOWE PLANET AIRSHIP

It does not need much imaginative power to foresee many of the uses to which an airship of the Planet type can be put, and it is not an unreasonable occupation to spend a few moments in contemplating these soon-to-be-realized possibilities.

AS PLEASURE CRAFT

For pleasure-craft nothing in the realm of transportation can equal an airship. Col. Garrick Mallery, with the pen of a ready writer, has given some idea of the exuberant delight he and his companions experienced when they ascended in the Lowe Airship of the old floating type. But what must it be to soar into the highest atmosphere like an eagle, knowing that your aircraft is under perfect control, that you can go hither or yonder as you will, visit friends here or there, land at pleasure, or continue your flight indefinitely over land or sea! Ere long every social club of any pretension will own its planet airship, with its navigator, ready at a moment's notice to take one or twenty of its members to any desired point. Women's Clubs will have the same freedom and pleasure, and it will be a sight witnessed every day to see members of such clubs gather at the Airship Anchorage, dressed as for social functions, enter their club airship and sail to a city twenty, fifty, a hundred miles away, where a sister club has provided a luncheon and intellectual entertainment for them.

NOVEL SIGHTS

But in addition to these novel pleasures that will soon become ordinary, men and women alike may see what hitherto has been witnessed only by the birds. One may soar over one's native city, visit Washington and look down upon the Capitol, follow the windings of the Grand Canyon, a mile above it; journey across deserts in perfect comfort; visit the top of the Sierras, and float over Death Valley in an aerial palace hotel. The most difficult part of this will be to convince the reader, just as it was difficult to get the ordinary mind to believe in telephones, wireless telegraphy, and the thousand and one other things which have had to be fought for by inventors.

FOR EXPLORING PURPOSES

For exploring purposes the Planet Airship will open up a large field and give a new impetus to adventurous minds in that it will make easily accessible those points of the earth's surface that hitherto have been reached only after tremendous expense, great hardships, sacrifices, or loss of life. High mountains, isolated cliffs, deep canyons with their de-

tached buttes (as in the Grand Canyon), the arid wastes of trackless deserts, rocky islands, are all now open to the personal inspection of man. For with his airship under perfect control he can land where he will, high or low, and make such investigation as he desires.

In a Lowe Planet Airship he can go from Behring Sea to North Cape and observe the wonders of the midnight sun in ease and comfort, with the sensation of visiting another world. The North Polar region, comprising an area larger than the whole of the British Isles, which has never yet been explored, may now safely be examined in detail and all its conditions learned, thus putting the final seal of knowledge to the discovery of the North Pole. The South Pole and its adjacent country can also be investigated with little or no hardship, comparatively little expense, and no risk of loss of life.

LONG DISTANCE AND DIFFICULT JOURNEYS

For practical long distance journeys the airship will afford advantages not possible by any other method of transportation. Places unpleasant or dangerous to reach can be visited with all unpleasantness and danger eliminated, for in ordinary weather, there are neither dangers nor unpleasantnesses in aerial travel. One has all the freedom and independence of the automobile multiplied a hundred fold. Space is annihilated and it is as easy to scale a mountain or descend a canyon as to go on the level; the snow clad heights or the sandy wastes are as easily traversed as the roads of a city, and the mud and slush of bad roads, the floods of heavy rains or swollen creeks and rivers are as inconsequent as the flying of a hen in the path of an automobile.

FOR MOUNTAIN MINES

To those whose occupations take them to great heights in inaccessible mountains the Planet Airship will be a godsend. It will also completely revolutionize many mountain industries, especially rendering profitable many mines which are now operated at tremendous expense. Supplies are now taken into these mines on the backs of mules, burros and men at a cost that only the richest mines can bear, but with a *Lowe Airship Freighter*, capable of carrying ten, fifteen, twenty or more tons of machinery, and all the needful supplies, a mine that has hitherto been capitalized for a million can well afford to pay dividends on ten or more millions, owing to the reduced cost of operation. Many mines that have hitherto been operated at a loss will speedily become dividend payers, and good mines that have had to be abandoned because of their inaccessibility will again be worked at a profit, while the profits on good-paying mines will be tremendously enlarged.

AIRSHIPS IN WAR

The possibilities of the use of airships in war are too great to be more than hinted at in such a cursory survey of the subject as this confessedly

is. Yet it must be apparent to all that with an aircraft capable of carrying many tons' weight, under perfect control and able to be propelled, up, down, or forward in any direction, or even stand still in the air, war as now conducted will soon be impossible. Fortifications can be inspected and destroyed, and battleships annihilated ere they can fire a gun upon their enemies. A fleet of fifty of these "dreadnaughts of the air" will completely revolutionize the art of war. They can be built and equipped for less than the cost of one battleship, and each one would be of greater service than the Atlantic and Pacific fleets combined. Yet the whole fifty could be stored away in one ordinary sea-going yacht, and be assembled, inflated, and put into practical operation, on sea or land, in a few hours, whenever needed

This, indeed, is one of the glorious possibilities of the airship, that, by its very destructiveness, it will render war impossible—a consummation devoutly to be wished by all who have the welfare of the human race at heart.

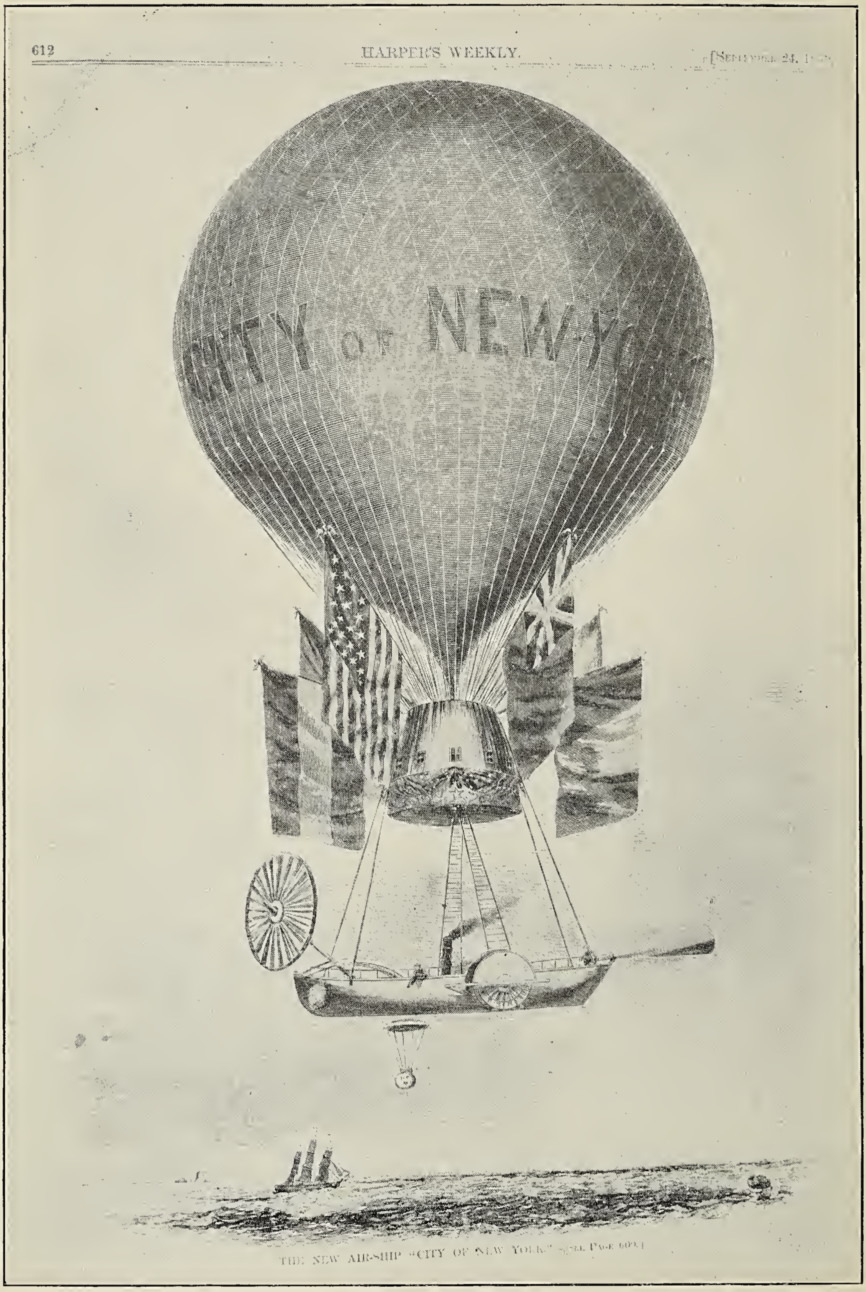
GOVERNMENT NEEDS

The United States government, therefore, is as vitally interested in practical aeronautics as any other government on earth. It has spent and is still spending hundreds of mililions on naval and land defenses, for it is thoroughly committed to the doctrines that in time of peace it must prepare for war, and that peace is best secured by a perfect readiness for war on a tremendous scale.

No other preparation for war can equal the building and equipment of fleets of the Lowe Planet Airship for military purposes, and the training of competent men to efficiently handle them. The peculiar climatic and topographical conditions of Southern California are ideal for this work. Training can be given here and experiments conducted as in no other spot on the Continent.

TRAINING SCHOOL AND PRACTICE GROUNDS

Practice manoeuvers and the training of classes in both army and navy, require a location with close proximity to sea and land. Here is the illimitable Pacific on the one hand, and the mountains and trackless deserts of the Mohave and Colorado on the other. The close proximity of the mountains affords ready opportunity for swift and direct ascensions, and the testing of air currents caused by juxtaposition of high peaks, low passes, desert areas and ocean expanse. The ocean and its uninhabited islands (within thirty or forty miles) afford exceptionable opportunities for naval experiments, and the desert enlarges these opportunities by adding immense and uninhabited areas on land. Practice stations can be established here with natural advantages equalled nowhere else on the habitable globe, for there are not only all the wonderful opportunities for practice and drill afforded by desert, mountain, plain, ocean and is-



Page of Harper's Weekly, Showing Professor Lowe's Mammoth Airship with Propelling Machinery

land, but the climate permits all-the-year-round experiments and manoeuvers, thus enabling students to be trained in one-third the time required in less highly favored regions; and at the same time both officers and cadets are within easy reach of the centers of civilization.

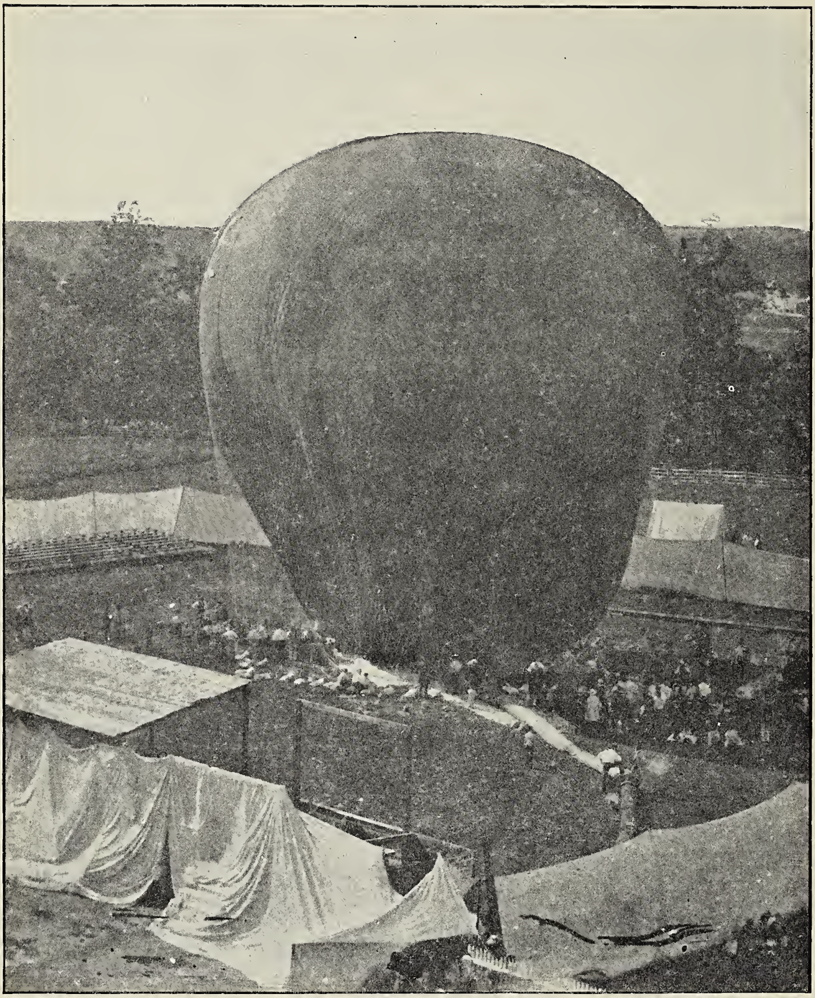
PRESTIGE AERIAL FLEETS AND TRAINING SCHOOLS WILL GIVE

The necessity and vast importance of these practical aerial schools cannot be over estimated. Until war has actually ceased, every nation must be prepared for its coming, and that airships will play the most prominent part in any future great war is self-evident to every thinking and observant mind. In future no fortification can be built that a Lowe Planet Airship cannot immediately destroy. No fleet of hostile battleships can approach our shores that a few Dreadnaughts of the air cannot destroy long before they have an opportunity to fire a single shot.

Aerial schools will be established not only in Southern California but wherever army and naval posts are already in existence. Here will be the natural center, the chief operating ground, the building place, the academy—the combined West Point and Annapolis of the Government's Aerial Navigation schools.

By providing itself with several efficient and well equipped aerial fleets and by the establishment of such schools the United States will command not only the profound respect of the nations of the earth, as being well forearmed, but will gain the necessary prestige that will make its voice the most potent and commanding in all future councils of nations, and especially in the international congress that undoubtedly ere long will be called to discuss and settle the new problems connected with the navigation of the air.

If the United States Signal Corps, which now has charge of all government aeronautics, could be empowered to draw on either the Military or Naval fund for, say, $100,000, half of which could be used for building and thoroughly equipping a Lowe Planet Airship for war purposes, and the other half to enable the government experts to make an exhaustive series of tests during the summer vacation, Congress would then, at its next session, without loss of time, be thoroughly informed as to the needs of the military and naval departments, and the amount it would be desirable to appropriate for aeronautic purposes.



Inflation of Professor Lowe's mammoth airship, near Point Breeze Gas Works, Philadelphia, on the early morning of June 28, 1860, from an old photograph. The hydrogen holder is but one-third inflated.

This was the airship in which Col. Garrick Mallery made the aerial voyage so graphically described on pages 41-44.

PROFESSOR LOWE'S AERONAUTIC EXPERIENCES BEFORE, DURING AND AFTER THE CIVIL WAR

To justify all the strong claims made for the Lowe Planet Airship might seem impossible. In this case, however, it is made easy by public records of absorbing interest, of which a brief but succinct *resume* will now be given.

HOW PROFESSOR LOWE WAS LED INTO AERONAUTICS

When a young man of little over twenty years of age, Professor Lowe's serious attention was drawn towards the varying conditions of the weather, and the effect these had upon the products of the agricultural world, and also upon the shipping industries of the country. His far-seeing mind perceived that if some method of forecasting the weather could be discovered timely warnings could be given to navigators thus preventing great losses of many precious lives. Herein was the germ of what afterwards became the U. S. Weather Bureau, organized and directed under such scientific and practical minds as Generals A. J. Meyer, A. W. Greeley and others.

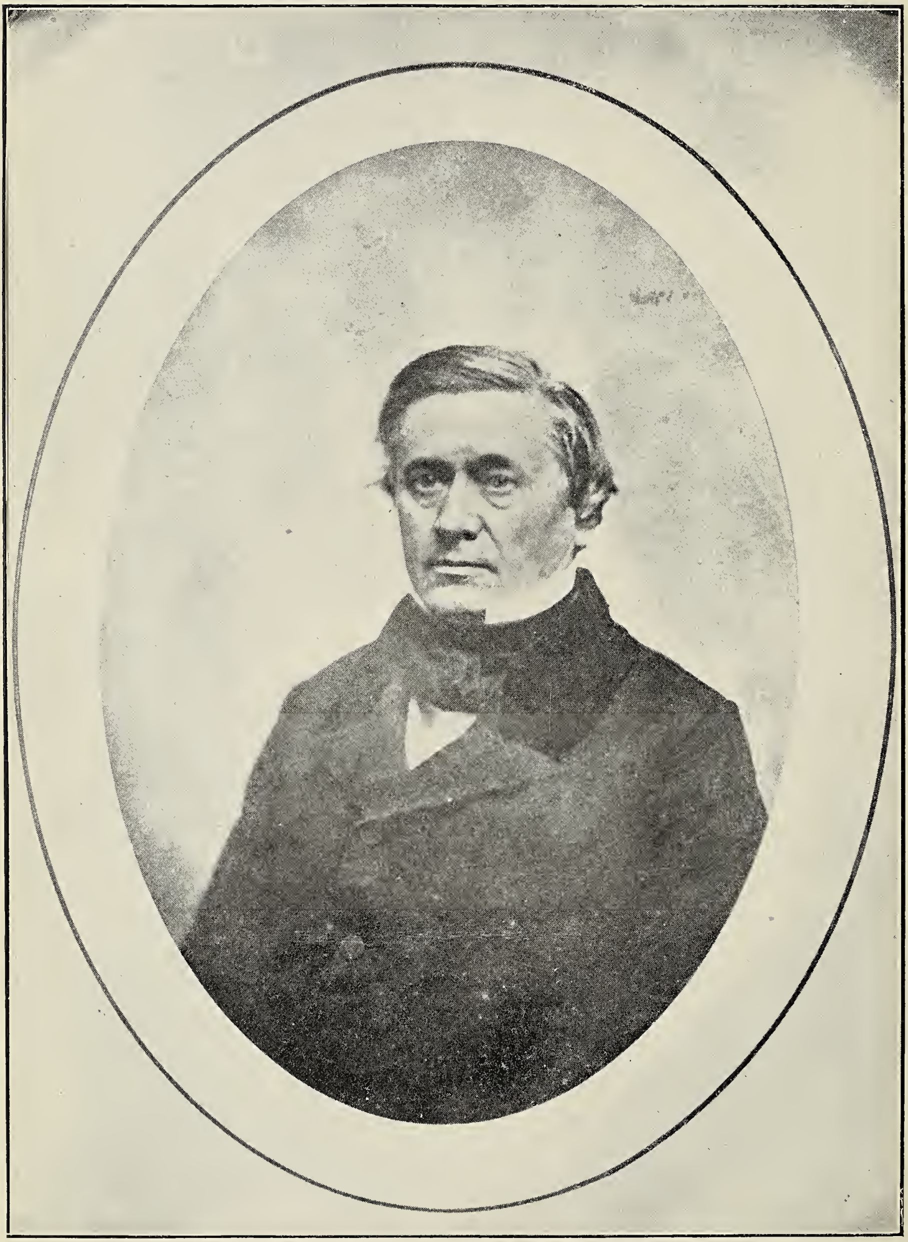
AIR CURRENT INVESTIGATIONS

These early day investigations led him to construct a balloon for the purpose of studying the various air currents of the upper atmosphere, and here after much and careful investigation he discovered the existence of an air current that, no matter in what diverse or various directions the lower earth currents flowed, invariably flowed eastward or nearly so.

BUILDING A MONSTER AIRSHIP

This discovery prompted the young aeronaut to the great endeavor of constructing a monster airship capable of lifting over twenty tons, with which he proposed to cross the Atlantic and study the air currents over the ocean. It was in this—the greatest airship ever constructed—that Garrick Mallery made his interesting trip as described on pages 41-44.

Desirous of turning these experiences to practical use Prof. Lowe suggested to the merchants of Philadelphia that here was a method by means of which they could communicate rapidly with the markets of Europe. It will be recalled that at this time (1858-60) the Atlantic Cable was not in operation.



PROFESSOR JOSEPH HENRY, L. L. D.

First Secretary of the Smithsonian Institution, one of the foremost and illustrious scientists of the world, who was most ardent and earnest in furthering Professor Lowe's plans for the advancement of Aeronautic Science.

THE MERCHANTS OF PHILADELPHIA INTERESTED

These quick-witted and keen-minded merchants were not long in seeing the advantages the young aeronaut pointed out to them, and they speedily interested their scientific and influential friends in the subject so that a number of the most prominent men in Philadelphia united in subscribing to the following memorial, addressed to Professor Joseph Henry, the learned Secretary of the Smithsonian Institution. Even at the signing of the Declaration of Independence, there was not a more representative class of gentlemen than were the signers of this letter.

"Philadelphia, December, 1860.

"To Professor Joseph Henry,
Secretary of the Smithsonian Institution,
Washington, D. C.

The undersigned, citizens of Philadelphia, have taken a deep interest in the attempt of Mr. T. S. C. Lowe to cross the Atlantic by aeronautic machinery, and have confidence that his extensive preparations to effect that object will add greatly to scientific knowledge. Mr. Lowe has individually spent much time and money in the enterprise, and, in addition, the citizens of Philadelphia have contributed several thousand dollars to further his efforts in demonstrating the feasibility of trans-Atlantic air navigation. With reliance upon Mr. Lowe and his plans, we cheerfully recommend him to the favorable consideration of the Smithsonian Institution, and trust such aid and advice will be furnished him by that distinguished body as may assist in the success of the attempt, in which we take a deep interest.

Jno. C. Cresson,
William Hamilton,
W. H. Harrison,
Henry Seybert,
J. Cheston Morris, M. D.
Isaac Lea,
Fairman Rogers,
James C. Fisher, M. D.
Thos. Stewardson, M. D.,
J. B. Lippincott,
Geo. W. Childs,
John Grigg,
S. S. Haldeman,
John F. Frazer,
George Harding,
M. McMichael."

Professor Henry's reply contained the following:

"Washington, D. C., December, 1860.

"It has been fully established by continuous observations collected at this Institution for ten years, from every part of the United States, that, as a general rule, all the meteorological phenomena advance from west to east, and that the higher clouds always move eastwardly. We are, therefore, from abundant information, as well as from theoretical consideration, enabled to state with confidence that on a given day, whatever may be the direction of the wind at the surface of the earth, a balloon elevated sufficiently high, would be carried easterly by the prevailing current in the upper or rather middle region of the atmosphere.

"I do not hesitate, therefore, to say, that provided a balloon can be constructed of sufficient SIZE, and of sufficient IMPERMEABILITY to gas, in order that it may maintain a high elevation for a sufficient length of time, it would be wafted across the Atlantic. I would not, however, advise that the first experiment of this character be made across the ocean, but that the feasibility of the project should be thoroughly tested by experience accumulated by voyages over the interior of our continent."—

(Signed) Joseph Henry,
Secretary, Smithsonian Institution.

TESTING THE AIR CURRENTS

As a result of this correspondence Professors Henry and Lowe had many personal interviews, and at last, in accordance with Professor Henry's suggestion, Prof. Lowe took one of his small balloons to Cinncinati and, after waiting until all the surface air currents from as far East as the Atlantic were reported blowing *Westward*, he made the ascent that was to demonstrate the existence of the permanent *Eastward*-flowing air current in the upper atmosphere.

Francis Metallic Life Boat—The Leontine of Philadelphia—with car of airship suspended by tripod for rigg'ng. Professor Lowe's Vertical Propeller, (operated then by hand power,) is on the bow of the boat, and was used for raising or lowering the mammoth airship without the discharge of gas or ballast. Used in the experimental voyage, June 28, 1860.

RECORD SPEED AND DISTANCE TRIP

The trip then made was the record long distance and speed trip of the world at that time, for in nine hours he traversed 800 miles, landing near the South Carolina coast at about one p. m. of April 20, 1861, having left Cincinnati shortly after 3:30 in the early morning. A full account of this trip is found on pages 127-156 in "Navigating the Air," a volume published for the Aero Club of America by Doubleday, Page & Co., of New York.

In this account the story is told of the suspicions of the Southerners into whose hands he fell, of his arrest as a federal spy, of the narrow escape he had from hanging and his ultimate release and return to Philadelphia.

CALLED UPON BY PRESIDENT LINCOLN

Fort Sumpter had already been fired upon, the rebellion was on, and he had seen the movement of troops towards the Southern Capital, Richmond. He was thus able to give valuable information to President Lincoln, and when the latter learned of his aeronautic experiences he called upon him to organize an aeronautic corps for the U. S. Army and personally interested himself in seeing that his plans were carried out. In Harper's Monthly for June, 1900, General A. W. Greeley thus refers to this and subsequent portions of Professor Lowe's work in the army:

> "Patriotically desiring to render service to his country, Professor Lowe brought his balloons to Washington, and sought the support of Professor Joseph Henry * * * Thus officially encouraged, Professor Lowe made many ascents * * * not only demonstrating the feasibility of military aeronautics, but on June 15th, 1861, crowned his services by installing a telegraphic office in the car of the balloon, from which, at a height of 1,000 feet, he opened up communication with President Lincoln in the White House, by sending to Lincoln the first dispatch ever telegraphed from an aerial station, and acknowledging the indebtedness of his encouragement of aeronautics in the Military service."

NEW INVENTIONS

During these aeronautic experiences with the federal army Professor Lowe soon learned that the ordinary methods of balloon inflation were extravagant and wasteful and at times impossible for field service—extravagant and wasteful in that the uncoated gas envelope or balloon allowed the gas to escape in the course of a few hours, and impossible in that it was not always possible to get the balloons filled where gas was manufactured and then transported to the field for active service. He thereupon experimented and soon invented a coating for his balloons which prevented the escape of gas, and at the same time perfected a transportable apparatus with which the gas could be made wherever needed in the field.

PROFESSOR LOWE DICTATING A DISPATCH TO GEN McCLELLAN DURING THE BATTLE AT FAIR OAKS. SKETCHED BY A. LUMLEY.

Professor Lowe dictating a dispatch to General McClellan after an observation on the Confederate position at the Battle of Fair Oaks. Orderlies waiting for dispatches are on the right, one of the Signal Officers of the Aeronautic Corps and a telegraph operator on the left. The smoke on the left indicates the battle ground, and in the background troops are marching to the field.—*From an old war print in Frank Leslie's Weekly.*

SIGNALLING AND TELEGRAPHING FROM THE AIR

He invented, (as stated by General Greeley), a system of signalling from the air, and also the aerial telegraph, as the following telegram shows, being the first message ever sent from the upper air to the earth below:

"Balloon 'Enterprise', in the Air, June 18, 1861.

'To His Excellency Abraham Lincoln,
President of the United States.

Dear Sir:—

"From this point of observation we command an extent of country nearly fifty miles in diameter. I have the pleasure of sending you this first telegram ever dispatched from an aerial station, and acknowledging indebtedness to your encouragement for the opportunity of demonstrating the availability of the science of aeronautics in the service of the country.

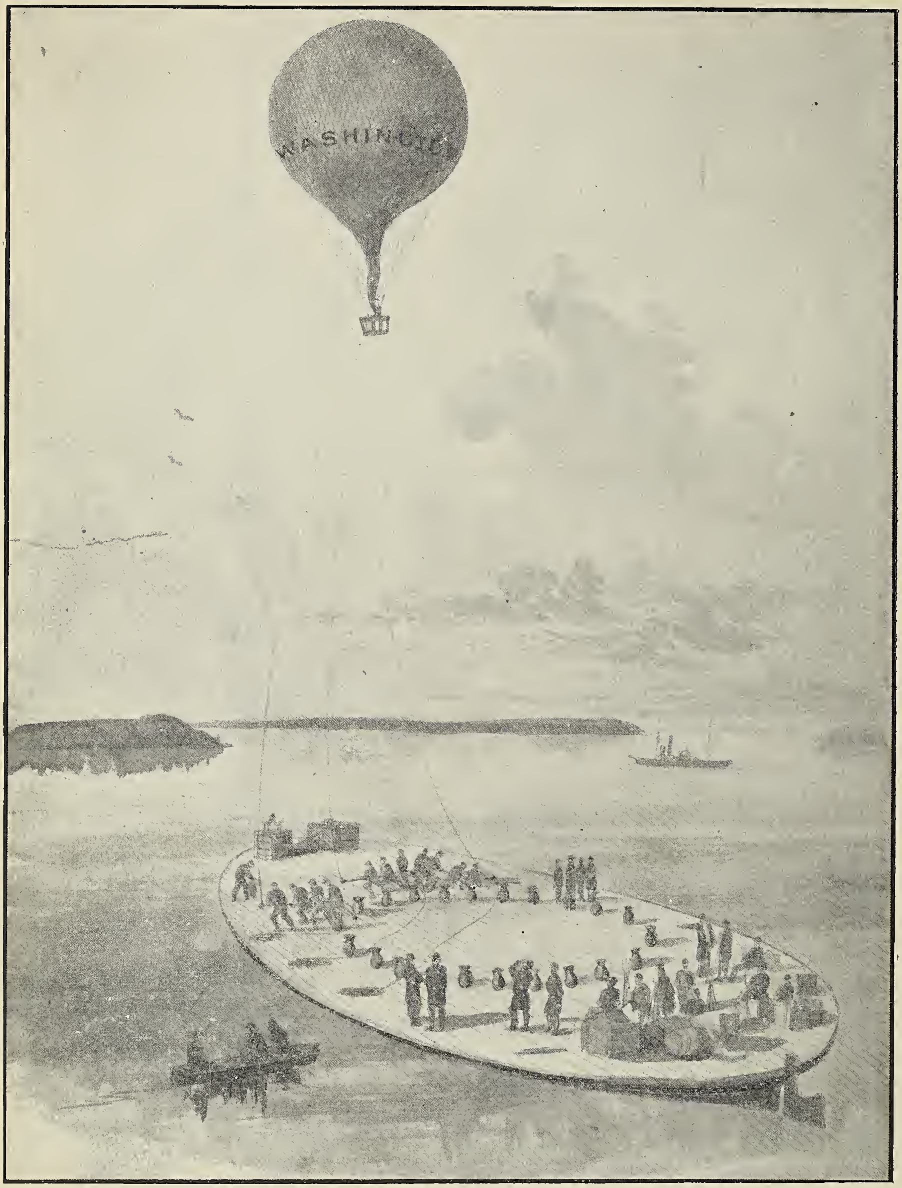
"I am,
"Your Excellency's obedient servant,
T. S. C. LOWE."

THREE THOUSAND ASCENSIONS

It is needless here to speak further of Professor Lowe's services for his country throughout the civil war. During the time he was engaged he made upwards of three thousand ascensions, several ascents and observations being made daily and often during the night. He built and equipped five balloons, for the handling of which about two hundred and fifty men were detailed, and several of whom were trained by Professor Lowe as his assistants. When his arduous labors broke down his health, and he was compelled to retire, these assistants carried on the work under his direction.

Dom Pedro, the Emperor of Brazil, also called upon him for the organization and equipment of an aeronautic corps for his army, and after war was declared between Brazil and Paraguay, he gratefully acknowledged his great indebtedness to the American aeronaut, at the same time informing him that by carrying out his methods, the war had been closed after a single battle.

The following, which are but a few from thousands of unsolicited and spontaneous expressions from army officers, statesmen, scientists and others, not only of our own but of other countries, attest most emphatically the appreciation in which many keen observers and those able to judge have held Professor Lowe's devoted work for his country during the trying epoch of the Civil War.



The above drawing is from one of the papers published during the war. It shows the first aeronautic operations ever made for naval purposes. A broad deck was erected on the hull of the Steamer "George Washington Park Custis," which used to ply on the Potomac between Washington and Mt. Vernon. The gas-generating supplies were on the stern and the manufacturing apparatus on the bow. When at rest the airship was anchored on the center of the deck. At the time the picture was made Professor Lowe was observing the blockade at Budd's Ferry below Mt. Vernon. This, in conjunction with another of his balloons on land, caused the raising of the blockade of the Potomac in a few hours, thus allowing our fleet of transports to pass by. This blockade had been costing the government upwards of a million dollars a day for nearly two months.

He operated with this craft on the Potomac, York, James and Pamunky Rivers and Chesapeake Bay during the Penninsula Campaign.

Opinions of Army Officers and Others on the Value of Professor T. S. C. Lowe's Services as Commander in Chief of the Aeronautic Corps of the U. S. Army

OPINIONS OF MAJOR GENERAL A. W. GREELY, THE GREAT EXPLORER, SCIENTIST AND AUTHOR, LATE CHIEF OF SIGNAL SERVICE, U. S. A.

"It may be safely claimed that the Union Army was saved from destruction at the Battle of Fair Oaks, May 31, and June 1, 1862, by the frequent and accurate reports of Professor Lowe."—*Harpers' Monthly, June,* 1900.

"The well planned and desperate attack of the Confederate forces at Gaines' Mills on the evening of June 27th would have been overwhelmingly successful, but for the information gained by Professor Lowe, who observed the movements, correctly interpreted and promptly reported them."—*Harper's Monthly, June,* 1900.

"The American Civil War of 1861-5 called into play all the resourcefulness and ingenuity, which have made the material and industrial progress of the United States the marvel of the World * * * Among the venturesome aeronauts was Professor T. S. C. Lowe, who proposed to make the trans-Atlantic voyage in a mammoth balloon."—*Harper's Monthly, June,* 1900.

"No one can deny that Professor Lowe, by his work during the Civil War demonstrated the economic value of war balloons in extended military operations."—*Harper's Monthly, June,* 1900.

THE CONFEDERATE GENERAL, E. P. ALEXANDER, THUS WRITES IN THE CENTURY'S WAR RECORDS:

"Even if the observer (Prof. Lowe) never saw anything, his balloons would have been worth all they cost, trying to keep our movements out of sight."

CAPTAIN BEAUMONT OF THE BRITISH ARMY IN HIS REPORT TO HER MAJESTY'S GOVERNMENT WRITES:

"In May, 1862, Professor Lowe ascended with General Fitz John Porter, whose interest and belief in War balloons, contributed to Professor Lowe's success. General McClellan and staff were standing under the balloon, anxious to learn the latest news of the evacuation of Yorktown. Scarcely did the balloon show itself against the sky, above the green forest line, before a terrific fire of seige guns began. The whole atmosphere was literally filled with bursting shells. One shot passed through the cordage that connected the car with the balloon, and struck near where General McClellan stood."

The Editor of the "*Century Magazine's War Record*" thus writes:

"Colonel Auchmuty of New York City, who made many ascensions in this balloon from the Camp near Doctor Gaines' before the battle, says that the Confederates had a Whitworth gun at Mrs. Prices' on the south side of the Chickahominy, with which they would fire at the War balloons (Prof. Lowe's). General Fitz John Porter made no fewer than a hundred such ascensions."

Prince de Joinville writes in his "*Narrative of the Peninsular Campaign*" page 47:

"The shells from the rifled guns flew in all directions with a length of range which had not before been suspected. The accuracy of this fire forced us to abandon all the signal posts we had established in the tops of the tallest trees. The balloon (Professor Lowe's) itself, whenever it arose in the air, was saluted with an iron hail."

CAPTAIN BEAUMONT OF THE BRITISH ARMY ON PROFESSOR LOWE'S WORK

The balloon staff, with McClellan's forces, consisted of one Chief aeronaut, whose exact rank I could never quite make out, but it was not lower than a captain, nor higher than a brigadier; he was a civilian, and, by profession, an aeronaut; he was very highly paid, the same as a brigadier; and as the military rank, I believe, in America, is in some way attached to, and determined by the pay received, *I fancy Professor Lowe must have been a brigadier; at any rate, he was a very clever man, and indefatigable in carrying out his work.*

By night or day, whenever the weather gave a chance of seeing anything, he was up, engaged in his observations. Under him was a captain of infantry, who had been instructed by Professor Lowe in the art of ballooning.

The captain commanded the men, some fifty in number, attached to the machine, and superintended generally every arrangement in connection with its inflation and use. He was also responsible for its transport, and that a due supply of materials was kept ready. The captain never went up himself; indeed he informed me that he liked the work below best, and confined himself to it. Under the captain were a proportion of non-commissioned officers, who knew more or less of the management of it, and the men who besides having a sort of reverential awe of the machine, knew nothing whatever about it. Either one or two sentries were always on guard detailed from the captain's party, who had the strictest orders to allow no unauthorized person to approach. * * * *

Captain Beaumont continues:

"The undermentioned is a resume of the balloon corps and apparatus with General McClellan's army:

BALLOON CORPS:	1 Chief Aeronaut 1 Captain, assistant aeronaut 50 Non-Commissioned Officers and Privates.	Requiring two Instructed men.

APPARATUS

2 Generators, drawn by 4 horses each.
2 Balloons drawn by 4 horses each (including tools, spare ropes, etc.)
1 Acid Cart, drawn by 2 horses, (including tools.)

Her Majesty's Government, in appreciation of the services rendered by Capt. Beaumont in introducing the Lowe Aeronautic System into the British Army, promoted him to a Generalship.

Office of Frank Leslie's Publications,
19 CITY HALL SQUARE,
New York, June 20th 1861.

Prof. Lowe
Dear Sir

Can you take one of my artists in your car when you make your reconnoitering trips

I have one following each wing of the Army and should much like to have the results of such trips on paper

I could not publish them untill a week after they occur so that the publicity given to them would not prejudice the Government plans.

Let me hear by return & oblige Yours truly
Frank Leslie

This letter was followed by the sending of Arthur Lumley, one of the most accomplished artists of the war, who spent a large portion of his time with Professor Lowe during the operations of the Army of the Potomac.

Headquarters Department of Washington,
Washington July 1st. 1863.

Prof T. S. C. Lowe
Aeronaut
Washington

My dear Sir.

It affords me much pleasure to be able to give you my feeble testimony in relation to the value of the Ballon service, whilst under your direction, with the Army of the Potomac.

The first time I had an opportunity to observe its value, was from near Pohic church, in the spring of 1862, when I ascended with you & observed the position & extent of the Rebel camps & a few days later, when the most of them had disappeared. This was the first indication we had of the commencement of the evacuation of Manassas.

I again had the benefit of your services, when on the morning of the 4th of May we observed that the enemy

had evacuated Yorktown.

Again the few days previously to the battle of Fair Oaks you furnished much valuable information. The rest of the time you were with the portion of the army so much to the right, that I did not learn what information you obtained.

From my own observation & experience, with the portable gas generating apparatus & others of your invention, I would consider your balloons ~~are~~ indispensable to an Army in the field & should I ever be entrusted with such a command would consider my preparations incomplete without one or more balloons

I remain
Very truly yours
S. P. Heintzelman
Major Genl.

The above letter was written by Major General S. P. Heintzelman, Commander of the U. S. troops at the Battle of Fair Oaks.

Washington D.C.
July 10th 1863

Prof Lowe
Washington D.C.

My dear Sir

Before we part I beg leave to testify to you in writing as I often have in words, my appreciation of the valuable services you have rendered the Govt. during your connection with the Army of the Potomac in the use of your "portable Balloons" in the various operations of that Army.

I have been up in them often and never made an ascent without coming down much better informed in regard to every thing in my vicinity than I could possibly have been by any other means

Valuable as your Balloons have been I feel satisfied that you could have made them still more so had you been encouraged by having more

facilities extended you.
I have ever regretted that our efforts to have your system of signals by means of rockets introduced were unsuccessful as I feel satisfied they can be made of great service both by day and night, and I know from observation they are made of valuable service by the enemy
I trust you will not be discouraged but will persevere in your laudable endeavours to serve the Govt. and the cause, feeling assured that in the end you will be able to do away with the prejudices with which you have had to contend, and prove to the world the great utility of Balloons and Balloon signals in the conduct of a war, and remain

Very truly yours &c
George Stoneman
Maj Genl.
Comdg Cavly Corps

Major General George Stoneman commanded the Cavalry Corps of the Army of the Potomac, and later became Governor of California.

Our March Against Pope

It may be of interest at the outset to relate an incident which illustrates the pinched condition of the Confederacy even as early as 1862.

The Federals had been using balloons in examining our positions, and we watched with envious eyes their beautiful observatories

as they floated high up in the air, well out of range of our guns. While we were longing for the balloons that poverty denied us, a genius arose for the occasion and suggested that we send out and gather silk dresses in the Confederacy and make a balloon. It was done, and soon we had a great patchwork ship of many and varied hues which was ready for use in the Seven Days' campaign.

We had no gas except in Richmond, and it was the custom to inflate the balloon there, tie it securely to an engine, and run it down the York River Railroad to any point at which we desired to send it up. One day it was on a steamer down the James when the tide went out and left vessel and balloon high and dry on a bar. The Federals gathered it in, and with it the last silk dress in the Confederacy. This capture was the meanest trick of the war and one I have never yet forgiven.

James Longstreet.

The foregoing is a facsimile portion of an article written by General James Longstreet (one of the principal commanders in the Confederate Army), for the *Century Magazine's* "STORY OF THE CIVIL WAR." In telling "Our March Against Pope," he begins by relating how the operations of Professor Lowe's balloons led to the Confederates attempting to emulate his example. A portion of the "silk dress" balloon referred to is now in Professor Lowe's possession.

Headquarters Sixth Army Corps,

Sept. 3 1863

Prof Lowe

Dear Sir

I take pleasure in certifying to the important service rendered by the balloon under your charge during the operations near Fredericksburg in May & June last. Full and frequent reports were furnished of the movements of the enemy and a vigilant watch kept on all his operations by the officer in charge of the balloon. Staff officers detailed for that purpose made frequent ascensions so to reconnoitre the position of the troops on the other side of the Rappahannock and obtained valuable information which could not have been procured

by any other means than
at my command. In situations
such as that then existing the
importance of careful balloon
reconnoissance and accurate
reports therefrom cannot be
over estimated.

&c I am very Respectfully
Your Obt. Servt.
John Sedgwick
Maj Genl Comdg
6th Army Corps

Major General John Sedgwick was the commander of the 6th Army Corps, which was the only command that won a victory during the battle of Chancellorsville.

War Department
Office of the Chief Signal Officer.

Washington, D.C. Dec. 15. 1876.

Prof. T. S. C. Lowe,

Aeronaut,

No. 1450 Walnut St.,

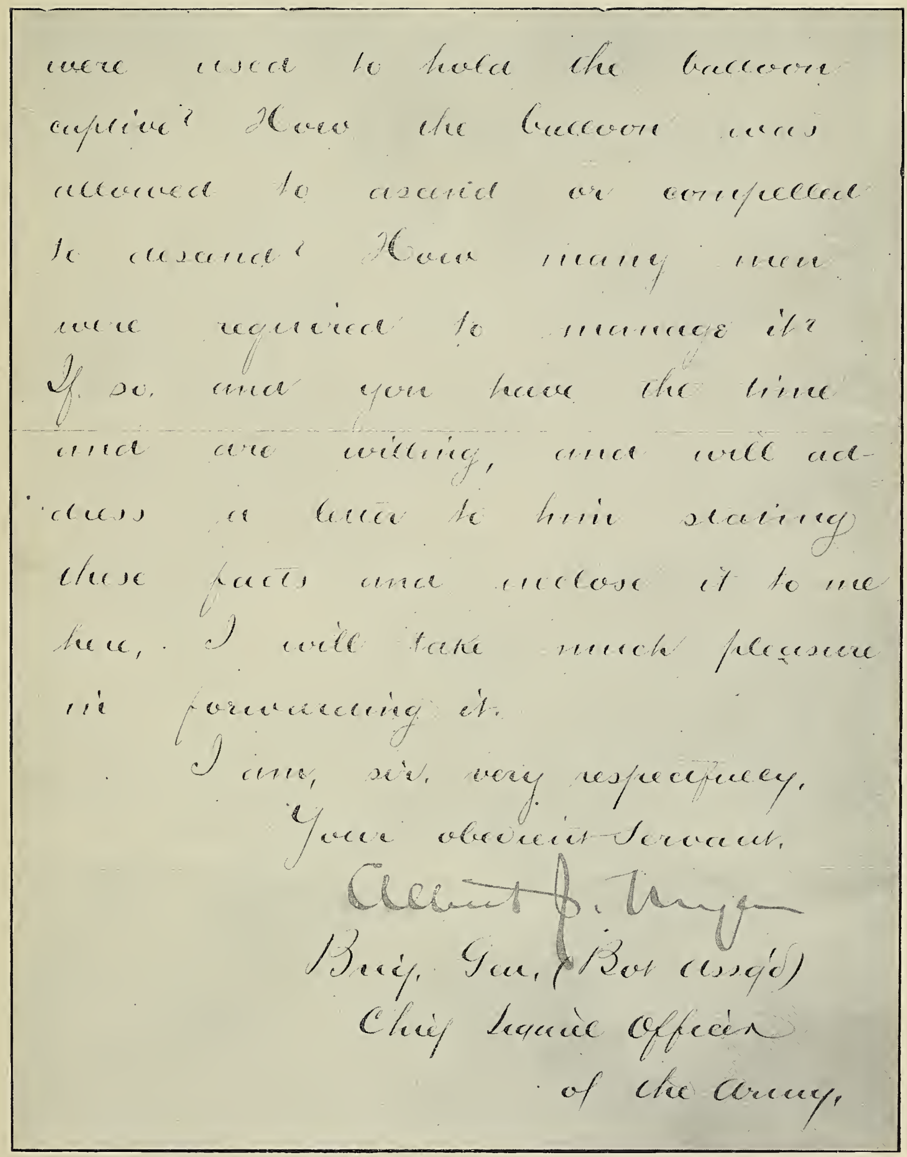
Philadelphia, Pa.

Dear Sir:

Commandant F. Perrier, of the French Staff, Member of the Bureau of Longitudes at Paris, wishes for some information as to use of balloons with the Army.

Do you remember perfectly the construction of your apparatus for generating gas as carried in the field? Its weight size &c.

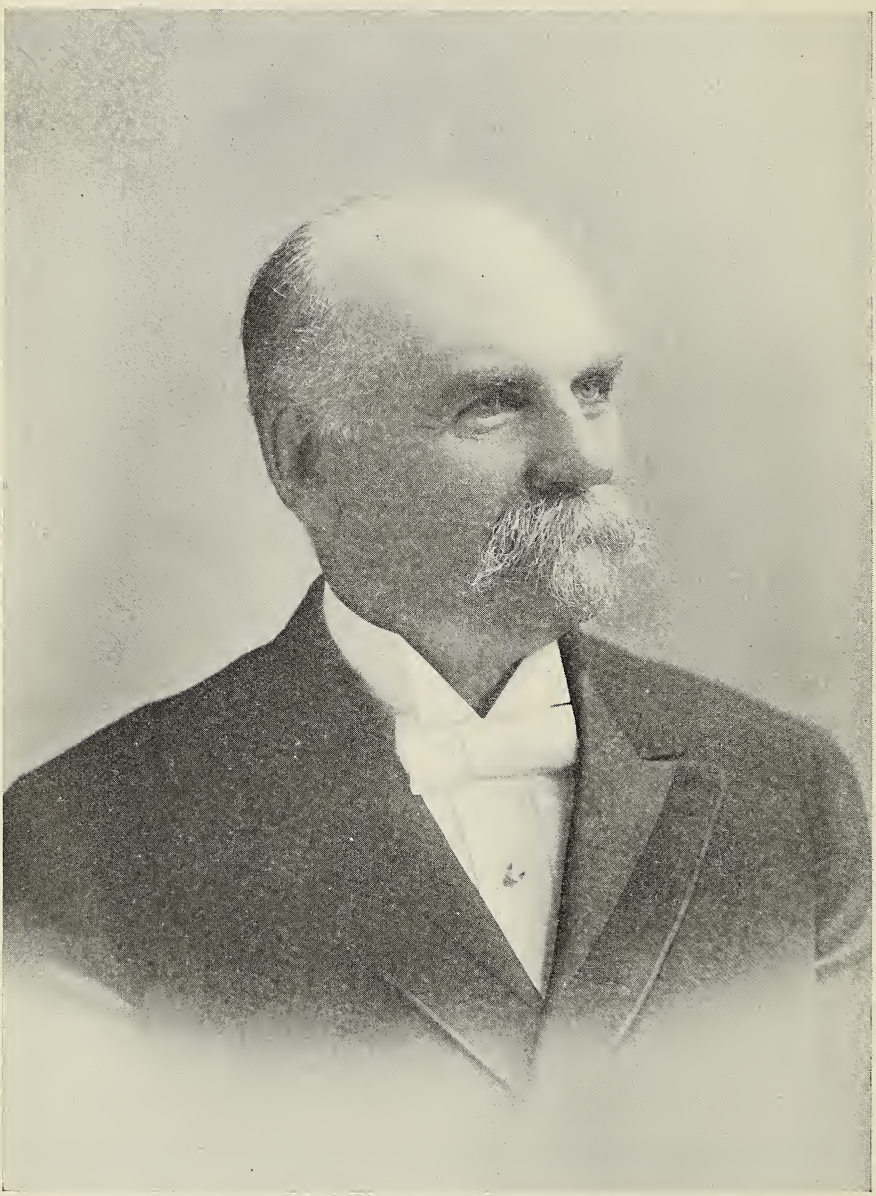
How many wagons it took to carry it? How many ropes



were used to hold the balloon captive? How the balloon was allowed to ascend or compelled to ascend? How many men were required to manage it? If so, and you have the time and are willing, and will address a letter to him stating these facts and enclose it to me here, I will take much pleasure in forwarding it.

I am, sir, very respectfully,
Your obedient Servant,
Albert J. Myer
Brig. Gen., (Bvt. Assg'd)
Chief Signal Officer
of the Army.

General Albert J. Meyer, Chief Signal Service Officer, was always most generous in recognition of the great value the work of the Aeronautic Corps was in furthering the objects of that branch of the army. This letter led to the introduction of Professor Lowe's system into the army and navy of France.



PROFESSOR T. S. C. LOWE

Professor Lowe's Other Achievements and Inventions for the Benefit of Humanity

At the close of the Civil War, as no proper engine was then built to make aerial navigation completely successful and practical, and having several inventions in mind of immediate benefit to mankind, Professor Lowe could see no object in continuing his aeronautic experiments until such time as a satisfactory means of propulsion was perfected. Hence he turned his inventive genius in the direction of perfecting a system of refrigeration by which rooms, containing meats, vegetables, fruits, etc. could be cooled to any required temperature. This led to the production of the artificial ice-machine. In the latter part of 1865 and the summer of 1866 he maintained an Aeronautic Station at Central Park, New York, and by use of two of his War balloons (which then had seen four years of rough service) he cleared sufficient profit from carrying passengers on short and long trips and from gate receipts to enable him to purchase a $100,000 steamship with which he demonstrated the great value of his ice-making and cold storage inventions, and upon which today the world depends for the transportation and preservation of its food supply.

INVENTED WATER GAS

Soon afterward he perfected his system of manufacturing Water Gas, which, by affording cheap light and heat, has materially benefitted and blessed untold millions.

BUILT MT. LOWE RAILWAY AND LOWE OBSERVATORY

With the competency his useful inventions had secured for him he moved to Southern California, and there, in the Sierra Madre range, above Pasadena and Los Angeles, he constructed the Mount Lowe Railway and established the Lowe Astronomical Observatory, both of which have ever since been in constant operation. This was the first mountain railway operated by gas engines, the first operated by water-power, the first where the electric brake was applied and the first all up-hill railway operated by electricity; and such was the solidity with which it was built, and the perfection of the safety equipments with which it was provided, that it has carried its hundreds of thousands of passengers without an accident—a record unequalled in the world.

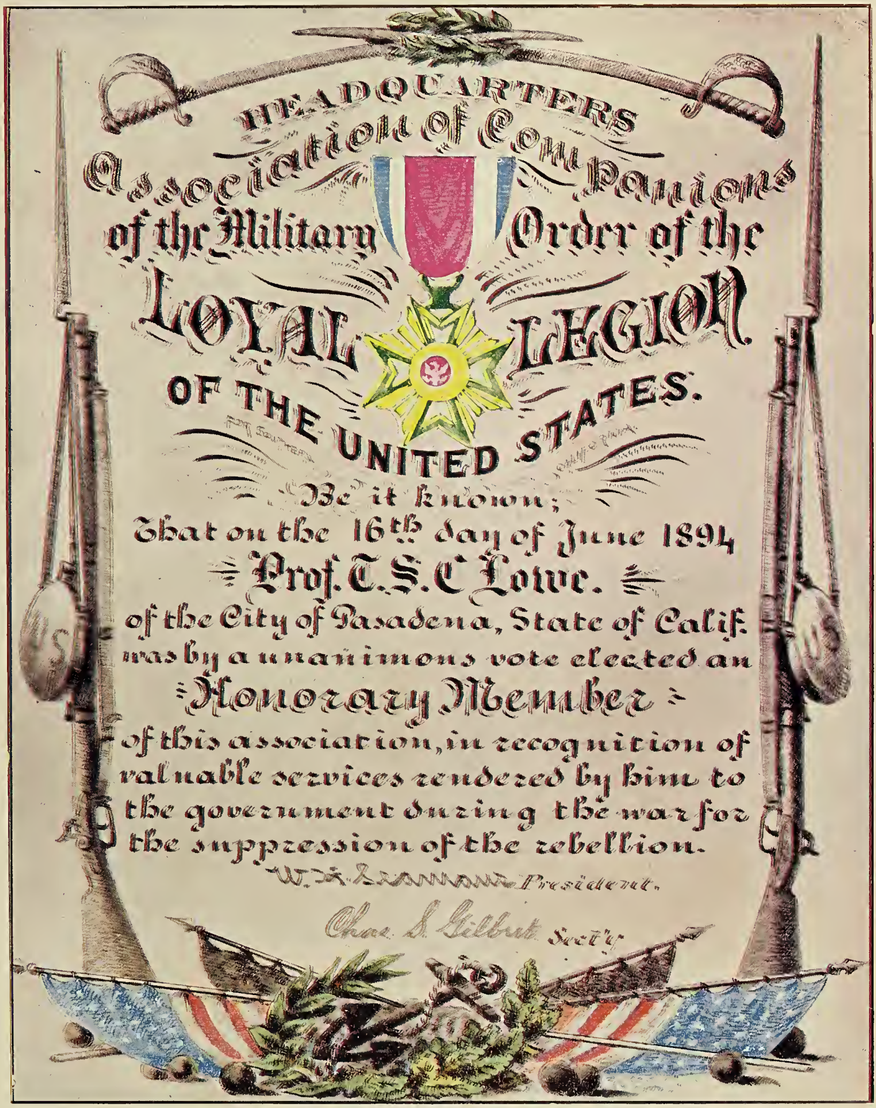
IMPROVED COKE, GAS AND POWER PLANT

Professor Lowe's latest and crowning achievement (except for the Planet Airship) is the invention and evolution of a new process whereby the production of coke and gas—and through these elements the production of power—will be revolutionized throughout the world.

One of the by-products of this invention—carbonite—enables sea-going power-driven ships to reduce the weight and cost of their machinery one-half, and their coal space fully two-thirds, while more than doubling their power and greatly increasing the speed at half the former cost of operation. It is also cheaply converted into Calcium-Carbide—a material that is rapidly coming into general use for industrial purposes as well as for lighting automobiles, isolated residences, barns, government light-houses, buoys, etc. The reduction in price owing to the cheap manufacture of this product will justify its enlarged introduction and thus tremendously increase its consumption.

This system also produces a coke that burns with the heat and smokelessness of pure anthracite, and costing less, will take its place, and thus ensure smokeless cities throughout the world. This system so materially reduces the cost of producing electric power that it will enable electricity to be used largely for many industrial purposes, including the smelting of all kinds of ores, heating and cooking in residences, hotels, and a hundred and one other places where the present high cost has rendered its use prohibitory.

This brief enumeration of Professor Lowe's successful and beneficial inventions which have worked untold advantages to the world, should give additional weight to the claims that he now makes for his new planetary airship.



HEADQUARTERS
Association of Companions
of the Military Order of the
LOYAL LEGION
OF THE UNITED STATES.

Be it known;
That on the 16th day of June 1894
Prof. T. S. C. Lowe.
of the City of Pasadena, State of Calif.
was by a unanimous vote elected an
Honorary Member
of this association, in recognition of
valuable services rendered by him to
the government during the war for
the suppression of the rebellion.

W. H. [illegible] President.

Chas. S. Gilbert Sec'ty

A RIDE IN THE GREAT LOWE AIRSHIP

By Garrick Mallery, Associate Editor Philadelphia Enquirer.

It is doubtful whether the sensation of traveling in an airship can be better described than was done by Garrick Mallery, published in the Philadelphia Inquirer, June 30th, 1860, after a voyage in the largest airship that has ever been constructed to this date.

Mr. Mallery was the Associate Editor of the Inquirer, a gentleman of education and fine descriptive talent, and later commanded a brigade of cavalry during the Civil War.

This account has just been furnished from the files of the Ridgeway Library in Philadelphia. It is entitled:

"A RIDE IN THE MAMMOTH OF THE AIR"

The ascent of Mr. Lowe's mammoth airship on Thursday last was by no means an ordinary occasion. *Soi-distant* scientific aeronauts had in treatises and speeches positively demonstrated that it could not float, and that if it rose at all, it would be also wholly unmanageable an account of its vast bulk, being ten times larger than any former vessel of the clouds. When to the admirable theories on this subject were added the actual fact, that it never HAD been up, there was some plausibility in these dire prophecies. Accordingly, when on the ground we were beset with gratuitous advice from the self-constituted professors and atmospheric voyagers, to the effect that it was madness to risk the untried experiment, and, as to our friends, we were ridiculed, threatened, cajoled, bribed, and wept over by turns. These reversed Cassandras, in respect to the truth and credence of their bodings, belonged to that large and respectable class of persons who will never believe in aught but the actual evidence of their senses.

So we held a council of war with ourselves in attempted cool reason, and positively could not see why an increase of capacity in a balloon must necessarily diminish its efficiency, or that a greater range in the amount of gas to be evolved on the occasion, and in the number of sand bags to be retained or thrown away according to the object of ascent or descent, should destroy control over the element to be navigated. On the contrary we were so unscientific as to feel much more secure in the magnitude of our conveyance, particularly after a careful inspection of its great strength and MANIFOLD SKILFUL APPLIANCES. Besides, it was contrary to nature that the Philadelphia Inquirer should not be well UP in everything, so we "WENT IN."

The history, size and dimensions of the GREAT WESTERN have recently been set forth at length before our readers, as was also an account of the ascent as seen from the earth, with mention of our fellow voyagers. It may not, however, be known that one of them was the officer engaged by Prof. Lowe to conduct the nautical part of his purposed expedition across the Atlantic, in case accident should make it necessary to take to the boats, as is often the case with other craft that attempt the ocean transit.

Well, the few uncut ropes are held by strong arms, the enterprising workman who seems to desire an ascent on the edge of the basket is induced to get down and put a bag of sand in his place, the other two gentlemen who determine at the eleventh hour to acquire aerial honors, scramble in when the swaying has begun, the "last dying speech and confession" has been made, all hands let go—and we are off! We don't believe it, however, in the slightest degree. There is no motion preceptible, and we ourselves are entirely stationary. Something to be sure is the matter with the field, it

has dropped. Perhaps that is the reason why the crowd down below there is making such a noise. They are frightened most probably. To be sure they have some reason for it is a rather alarming occurrence for the solid earth to fall down in that way, especially when all nature is so calm, and the sun shines so happily, and our car is so nice and fixed. So we feel badly about our unfortunate fellow beings who are momentarily becoming smaller. Suddenly a brilliant idea seizes us that we have actually begun the great ascent, and we forthwith begin to wave the flags and hurrah and jump. No, we don't jump, for there isn't room; but we would if we could. The mites down below give cheer after cheer responsive, and run futilely in our course, and we fly away.

Although nothing would have been easier than to have risen immediately to a great height, yet as the lower breeze was northerly and light, we purposely remained in it, as thereby a deliberate view of the City and its environs was presented that could not be hoped for once in a thousand times. We had precisely the day, the hour, the current and, above all, the balloon for a bird's eye inspection of Philadelphia, so sailed calmly on, silent, and ravished with ecstasy.

At an altitude of three thousand feet we look down fondly on Gray's Ferry, Darby and the Park, scenes of our equestrian pleasures, and then turn to the sparse houses of semi-rural Moyamensing, picturesquely isolated in green lakes and foliage. Next we glide on over the great city, seeming to lie asleep in that soft summer evening, with never a breath to disturb its happy rest, save the vague murmur of life which steals upward toward us, like the distant hum of invisible insects. We are higher now, and to the naked eye vast buildings like the Continental are distinguished chiefly by their known position; but as we pass along, the streets radiate on all sides with mathematical exactness, bordered with faint green lines of foliage. The public squares are patches of verdant enamel, and the spires point up at us with the beams of the sun shining from their whiteness until they only can be likened to the hoar frost spearing on a window in winter. Far away Girard College is discerned in the distance as an ant-hill of marble dust, and Fairmount is found in a fairy toad-stool, with the Schuylkill curving close to it like a silver thread dropped, perhaps, from the robes of Titania herself. But it is perfectly in vain to attempt any description of this most exquisite scene, which naught but the colors of the most gifted could pretend to convey to any who have not beheld it. Indeed, it was all to us but a seeming picture seen in an enraptured vision. There was no reality about it. We were real, and the car, but everything else was a midsummer night's dream. It was only by an effort of reason, or when, through a powerful glass, we distinguished animals in motion, that we realized the home of seven hundred thousand souls to be other than a microscopically beautiful toy.

When nearly above the office of the Inquirer, we celebrated the occasion by flying out ballast and shooting upward, which turned us more to the east, and we were above the Delaware, at an altitude of about a mile. Here we verified the fact that we could see with the naked eye the bottom of the river, and with the large spy glass clearly distinguish the great stones in its bed. Indeed, one of our fellow voyagers insisted upon it that he observed the motions of the fish. Certain it was that the ripple of the plying steamers was most marked, and when we turned to the shipping, we involuntarily repeated Shakespeare's description of the view from the cliff of Dover; whereupon we were filled with a "sacred rage," first, because the Bard of Avon flourished before the invention of balloons, whereby he could not immortalize the scene before us; and likewise at ourselves for being so utterly incapable of giving portraiture in language to what we were privileged to behold. Having taken a patriotic squint at the Island of Smith, and the still more celebrated Tinicum, we reached the Jersey side at five minutes past six observing Camden in all its glory. The current took us more directly toward the east, and we for half an hour or more followed closely the Camden and Atlantic Railroad, which could only be distinguished from the turnpikes by the aid of a glass. In the moving panorama, the fertile fields of East Jersey formed a most beautiful portion, with the Rancocas and Cooper's Creek winding snake-like through wee, oblong enclosures, distinguished only by the different colors of ripe wheat, growing corn, and other tokens of peace and plenty. Toward the ocean, a bank

of cumulus clouds rose up, and in the west the city was growing dim. We passed over Haddonfield and near Long-a-coming and Waterford then began to go much higher and faster, having passed right through a fleecy cloud. Beneath us stretched almost interminable pine forests, with the white sand sparkling here and there in tiny patches. We were at this time at the highest altitude attained during the trip, about three miles, and moving to the east, at the rate of at least sixty miles an hour. Here the earth appeared convex instead of concave, a phenomenon often observed and accounted for, but none the less curious, and the spirits of the party became almost as high as the barometric location of their bodies. We individually got up the ladder into the hoop and insisted on singing songs, which, owing to the rarefaction of the air and the echo from the balloon, had quite a stentorian effect. At this point, as we were far above the smoky haze surrounding the earth, and also the region of clouds, the sky looked more beautifully blue and vivid than can be conceived; the moon was almost as bright as it is usually at night, and the sun, which was nearly set to the poor people below, gave to the few clouds tints to us hitherto unknown.

We may here mention that during the voyage we brought "Sol" up and down several times, thus having a variety of sunrises and sunsets within the space of minutes. The atmosphere, even at our greatest elevation, was not so cold as was expected, owing to the rays of the sun being generally refracted from the hazy clouds below. The chief physical manifestation of our situation was in the ears, for when descending from a more rarefied to a denser atmosphere there was a whizzing, much like that in the diving bell, and from the same cause.

Although it had been the aeronaut's intention to reach the ocean, which now was visible, the sails on it being seen by the telescope, yet a delay of two hours, occasioned by the vastness of the preparations before starting, limited the time so that it was an alternative to land on a somewhat uninhabited coast without daylight to direct us to a proper spot, or to take the back track. The latter course was most prudent in reference to the securing of the balloon, and as affording better opportunities for its conveyance to Philadelphia. So we came down very fast, aided more than was entirely desired by the falling dews, and the contraction of the gas after the sun's rays had so much diminished. However, by a wholesale throwing off of ballast, we kept up at a safe distance, proceeding in a curve to the northwest, until observing that a crowd was gathering from all points of the compass in the neighborhood of Medford, evidently calculating on our descent, and shouting loud invitations, we gratified them and secured their assistance. A large number of willing men caught hold of our long trailing rope, by Mr. Lowe's direction. Our gas was allowed to escape freely, and we landed on a large sand-bar, one of the best places that could have been selected, at a quarter past eight, AFTER ABOUT SIXTY MILES OF THE PLEASANTEST VOYAGE IT IS POSSIBLE FOR MAN, THE UNWINGED BIRD, TO TAKE.

But something more was accomplished in this aerial trip besides a joyous time for the passengers. IN THE FIRST PLACE, THE EXPERIMENT ABOUT THE BALLOON ITSELF SUCCEEDED TO THE VERY MOST SANGUINE HOPE. THE MONSTER, IN ASCENT AND DESCENT, AND IN THAT GENERALLY MOST DIFFICULT MATTER OF LANDING, WAS AS THOROUGHLY UNDER THE CONTROL OF ITS SKILFUL BUILDER AS EVER WAS A HORSE IN HARNESS. It had not been inflated to the full capacity of 725,000 cubic feet, simply because it was not necessary to purchase so much gas when the weight to be carried was, to the said monster, so small, being only about four tons surplus which was easily carried with the three hundred and fifty thousand feet used. But it is perfectly plain that with the proper amount of ballast, or the arrangement of car, boat, etc., properly belonging to the apparatus, the airship can be worked just as well, that is to say, perfectly.

WHEN MR. LOWE WAS OVER THE CITY, MANAGING HIS GREAT CREATURE LIKE A CHARM, HE BURST OUT FROM THE HOOP ABOVE INTO THE INVOLUNTARY EXCLAMATION: "HERE AT LAST IS THE GREAT WESTERN AFLOAT, AFTER ALL THE PROPHESIES AGAINST HER, AND HALF A MILLION WITNESSES TO THE FACT!" WELL MIGHT HE REJOICE. AFTER

YEARS OF LABOR AND HARDSHIP HE HAD TRIUMPHED OVER EVERY OBSTACLE, in which the opposition of rivals was not the least, and looks forward to the full and speedy realization of his plans in a TRANS-ATLANTIC VOYAGE. In regard to the latter project, the EXPERIMENT ALSO WAS SIGNALLY SUCCESSFUL. IN THE MANY RISINGS AND FALLINGS—tried for the purpose, it was perfectly evident that when at a certain height WE COULD ALWAYS MOVE WITH WONDERFUL RAPIDITY TO THE EAST. We could easily have gone a mile or two higher, and have been over the sea at short notice, in a steady current of one hundred miles, or more per hour, and this fact, from the many observations made on the subject at various points, has convinced the great navigator that his completed plan is feasible.

It seems to be the conceded duty of all who come from cloudland to describe their "sensations," in which, *Bien Entendu,* is not included any question of personal courage, in which few will acknowledge a deficit. For our "single selves" the feeling was purely one of exultation. There was, indeed, so little seemingly to call for them, that strong nerves were quite at a discount, and everything seemed as stable and well regulated as if our little suspended car was a recognized part of the solar system, marching regularly in secular progression to the astronomical bourne of Gamma Leonis.

To be sure there was nothing to be vain at, for we were kept up by hempen cords, not our own muscles, and the skill was Prof. Lowe's, none of ours, yet it seemed no improper pride to glory in being one of a race that has accomplished and is destined to accomplish mighty things. And we exulted without personal feeling in recognizing still better the truth that Providence had set no limits to human energy. Foolish or not, the fact was as we stated, and it required but a little more freedom to fancy's reins for us to be satisfied that our airship was the *original and only genuine planet Earth,* and that the pretended one below was a mere well executed imposition.

From the greatest height reached on Thursday, there was a horizon of eight hundred miles, and though, of course, but a small part of that immense space was perceptible even to the most powerful instruments, yet their range was vast indeed.

In conclusion it may be put down as a curious coincidence that, on the 28th day of June, 1860, the GREAT EASTERN, the largest sea-going vessel, arrived at the port of New York, inaugurating, it is said, a new system of ocean navigation, and that on the same day the GREAT WESTERN, still larger in proportion to the rivals of its own kind, left the city of Philadelphia, to commence, it is possible, a yet more novel era in the navigation of the air.—*Philadelphia Inquirer, Saturday, June* 30, 1860.

From the Pacific to the Atlantic in a Lowe Planet Airship

An imaginary report made by Wm. H. Knight, Vice-President Southern California Academy of Sciences, and read by him at Simpson Auditorium Los Angeles, California, November 13, 1909:

FIRST AERIAL VOYAGE OF THE GREAT PLANET AIRSHIP

Reported by Wm. H. Knight

Let us suppose that one of Prof. Lowe's new type of airships shall be chartered by a company of thirty to fifty passengers for a transcontinental journey from Los Angeles to New York.

We note that its luxurious car is equipped with ample dining and sleeping accommodations for its journey across the continent.

The great airship is advertised to leave its station in one of the suburban parks on the 1st day of June, 1910, at 12 o'clock. An immense concourse has assembled to witness its flight.

Its passenger list, together with a crew of ten scientific and operating men, has been published, not only in the local papers and in those of the cities along the scheduled route, but in all the journals throughout this country and Europe.

The anchors which hold the impatient monster to the earth are now released, and away it soars, graceful and majestic, truly like a thing of life, conscious of its mission and destiny.

In a few moments the kodaks of Pomona and Covina are taking snap shots at this leviathan of the air. A little later, every face in Redlands and Riverside is upturned, and every eye is noting its wonderful flight.

Through the passes of the lofty San Bernardino range it wends its airy course, startling the eagles and condors in their mountain eyries.

High over the Mohave Desert and the gleaming Colorado River it flies, then bending its course to the northward, follows the windings of that wonderful gorge—the Grand Canyon. Here the passengers gain birdseye views, never before vouchsafed to the eye of man, of the magnificent scenes in that profound cleft of the earth's surface, and from a vantage point undreamed of by Major Powell who first penetrated its deep mysteries.

As we proceed on our novel and delightful journey, there looms in the distance a portentous storm. If we were on a railway or ocean steamer, we should be compelled to plunge directly through it and take whatever consequences might ensue.

Shall we turn back or descend to earth, and wait till the fury of the storm is over? Oh, no! We immediately rise above the storm-cloud into the bright sunshine. and serenely continue on our destined course. Meanwhile we watch the fitful play of lightning-flashes below, and listen to the deep-toned thunder as its reverberations roll harmlessly from cloud to cloud in the thick elemental conflict beneath us.

But look yonder! What are those beautiful objects flitting about so gaily above the storm-cloud, bathing their bright-hued wings in the warm sunshine? Ah, they are butterflies, darting hither and thither as if they were hovering over the petals of a flower garden.

But how did these delicate creatures get here—a mile above the earth, and what are they seeking in the untenanted sky? Instinct has taught them, when the storm gathers, to do just what reason has prompted us to do, that is, to soar above the dark and angry clouds and bask in the beautiful sunshine. (This remarkable phenomenon was witnessed on several occasions by Prof. Lowe in his early balloon excursions.)

And now let us for a moment take note of our sensations in this aerial journey. From our comfortable reclining chair we are glancing out over the picturesque, ever-changing landscape, and we remark that there is nothing more delightful than the soft, gentle motion of a craft, sustained by a buoyant power, sailing through the viewless air.

There is no sense of dizziness like that of looking down the side of a high building, where the vertical wall connects the eye with the ground. It is as if you were on another planet, watching the world roll by.

It has been described by aeronauts as the very poetry of motion. For once you seem to bid defiance to the power of gravity which has bound you slavishly to earth all your life.

You exult in the wild freedom and independence of a bird, which, resting on poised wings, sails serenely over field and lake, over the habitations of men and the mountain crags, rejoicing as it cleaves the ambient air and compares its swift flight with the creeping objects painfully toiling among the molehills below.

But while the great airship, obedient to its motors and its helm, is speeding on its way over city and stream, through wooded valley and rugged gorge, the wireless telegraph on board is sending messages of its hourly progress, and receiving news of world-happenings from everywhere.

Consequently, the people of Salt Lake City are apprised of the hour of approach to that locality, and are thronging the public square to welcome its advent. Here the Planet Airship makes its first landing, 800 miles, from its starting point, rests on terra firma for two or three hours, takes in refreshments and supplies, then the passengers re-embark to proceed on their way till they reach the next stage of their journey at Denver, where they receive a like welcome.

And these receptions will be repeated, with varying and novel changes of scene, and of civic method of celebrating an event so unique, at Omaha, at Chicago, at Cleveland, and at Buffalo, or if we pursue a more southern route, at Kansas City, St. Louis, Cincinnati, Pittsburg, and Philadelphia.

Finally, after traversing a continent, the long-heralded Planet Airship will descend into a suburban park of New York, amid a throng of countless thousands of people—as large and enthusiastic as that which gathered in Berlin on a like occasion, to honor the arrival of Count Zeppelin in his huge aircraft.

Throughout its transcontinental journey the movements and progress of our historic Planet Airship have been noted in the press dispatches of the world with the same minuteness of detail that was given to the recent Presidential tour from Washington to California.

Furthermore, the denizens of all intermediate towns and cities, of farm and prairie and hillside, were on the alert to catch a glimpse of this advance messenger of the aerial fleet which is to cleave the cerulean realms in the near future.

And these people, in city, hamlet and countryside, from ocean to ocean, were on the watch day and night, for buglenotes from the sky woke the echoes by day, and electric lights shone from the cabin windows at night.

But there are other uses for the Planet Airship than for the transportation of passengers. This new type of airship, invented and perfected by our fellow citizen, Prof. T. S. C. Lowe, already of international fame on account of other epoch-making achievements, notably the construction of military balloons during the Civil War, the refrigeration of steamships, the economical production of fuel and illuminating gas, and the construction of the first spectacular mountain railway, this crowning achievement, the Planet Airship fully capable of performing all that is promised of it, will not be a mere aerial transport for pleasure excursionists, giving them new and undreamed of sensations of birdlike speeding through the empyrean; but it will also become an arbiter of peace among the nations of the earth, a determining factor in moulding the magnificent new future of a regenerated humanity.

In what way will Prof. Lowe's Planet Airship become a direct agency for obliterating war and inaugurating an era of peace?

Gentlemen, your bodies are the ones which will be fed to the bullets of the enemy in time of war. Is there anything in these days of huge armies and swollen navies that can avert an evil so dire, so grim, as battle-fields strewn with the mangled bodies of the slain?

Yes, there is an effectual remedy at hand. Powerful planet airships shall be transformed into aerial dreadnaughts, panoplied with deadly missiles. They will swiftly, noiselessly, dart to the scene of conflict; then, poising over fortified positions, assembled fleets, and armories guarded only against approach by land or sea, deal destruction, swift and complete to each of them. Armed hosts will be utterly powerless to contend with an enemy so mysterious and so invincible.

My friends, these terrible engines of the skies will force the responsible heads of every government on the globe to confer together and arrange terms of international amity.

In other words these aerial navies will quickly bring about the era pre-visioned by the poet when

"The war-drum throbbed no longer,
And the battle flags were furled,
In the Parliament of Man,
The Federation of the World."

Ladies and Gentlemen, are these pictures that I have drawn—luxurious journeys through the air, blotting out the scourge of war—are these the vagaries of a dreamer?

No, no! they are the sober prevision of realities which will as surely come true as that the race is marching onward to accomplish greater things in the arts, in scientific achievement, and in human betterment, than have been conceived in the inspired moments of the most hopeful optimist.

The Present, earth-bound: Wars and rumors of war.

The Future, angelic flight: Peace and the beautiful arts and sweet security of Peace.

Professor T. S. C. Lowe Makes Real Conquest of the Air

By Professor Edgar Lucien Larkin,
Director Lowe Observatory.

Professor Lowe did a great work in early manhood before and during the Civil War. In the opinion of able military experts he saved the United States from being divided into two nations during that War.

Now he is to round out an eventful life of usefulness by a genuine conquest of the earth's atmosphere, in the safe and rapid transportation of passengers, merchandise and the United States Mail, and these through adverse air currents, clouds, fogs and storms. He will save the Nation's face, in the eyes of all the aviators in the world, and make his airships a household word in all languages of the habitable earth.

He erected the Lowe Observatory on the summit of Echo Mountain. Before that he built the great inclined railway up the mountain side, and extended to a still higher altitude the fairy railroad, whose work it is to bring startled visitors from all parts of the world to this cliff above the clouds.

These two, the Observatory and the Railway, could fill up an ordinary life career with honor, but they are mere episodes in the activity of Professor Lowe's life.

His forthcoming airship will be able to rise and descend at will, above and below adverse currents, thunder storms, lightning and troubled strata. The engines will be a concentration of great power in a minimum of space. All polar mysteries will be revealed. It will be as safe to visit either pole of the earth as to go from Los Angeles to New York, London or Paris. The time required to make one circuit of the earth will be one month; twelve excursions annually. Unknown regions of the globe can then be explored and mapped in ease and comfort, since the great gas holder will retain its hydrogen during months, or even a year, with its full efficiency of lifting power. Sahara, Borneo, Thibet, Siberia, Central Asian deserts, the Himalayas and regions round and about both poles will soon yield their long-time hidden mysteries.

The master mind who can create this Airship has plans for making many of them, not only for pleasure and gaining knowledge in this new science, but also for industrial uses, whenever explorations or transportations in inaccessible places are desired, of which there are many.

It can be made to float over and enjoy the sunshine of both the North and the South Polar regions. Plans are already being made for parties desiring such a method of reaching various parts of the earth heretofore unexplored.

The sphere on which these temporary dwellers in atmospheric space will reside, to all intents and purposes, is for the time being as permanent as is the earth itself.

His is not anything that resembles an ordinary balloon, but rather a new creation that can be handled and propelled at will and remain at any elevation desired, for any reasonable number of days or months.

Unlike ships at sea, when once in the air, there are no obstructions to run against, no strain through storms to cause the airship to spring a leak, as is often the case with sea-going ships, therefore, the Lowe Airship is that much safer, to say nothing about its ability to soar and keep above all storms.

A commercial era of great importance is soon to open; the transportation problem is now solved; passengers can avoid the discomfort, dust and danger of railway travel and terrors of the sea.

Professor Lowe is of a typical scientific mind, and is today one of the real scientific men of the United States. Every problem of aerial flight has been solved to practical completion.

The Professor was born in New Hampshire in 1832. By 1858 he was actively engaged in his life-work of conquering the almost, to others, insoluble problems of Aeronautics, and many other great utilities.

His voyage in the largest airship ever built was made on the day that the "Great Eastern" steamship arrived in America June 28th, 1860. At this time he exhibited his balloons and large airships to the Japanese Commission to the United States, in charge of Commodore Perry, who, ten years previously, had opened the ports of Japan.

He made a balloon voyage from Cincinnati, Ohio, at 4 a. m. on April 20th, 1861, and at noon on the same day descended near the ocean in South Carolina, traveling a distance of 800 miles.

On his return North, after making the quickest time of any traveller on record to this time, either in the air or on land, he entered the service of the United States Government.

He made repeated ascents over the Armies of the Confederacy, and gave accurate information to Federal Officers by means of telegraph and signals. This information saved the Union of the States, that is, it prevented Washington from capture, for if the Capitol had fallen, Europe would have recognized the Southern cause.

Professor Lowe came West in 1887, and immediately started work in Southern California. The great mountain railway, Alpine Tavern and the Observatory were opened in 1894, and materially aided the Southland on its momentous career of advertisement and advancement.

The Comprehensive Water Gas System, invented by the active brain of Professor Lowe, completely revolutionized the gas industry of the country and reduced the cost to such an extent that all, instead of the few, now enjoy its benefits.

He now has other inventions of still greater import ready for capital to enlarge itself while benefiting the world.

None of them however, can do so much for the happiness of the inhabitants of the earth as will the introduction of his Planet type of Airships

PRELIMINARY ANNOUNCEMENT

Professor Lowe's Forthcoming Book

"MY AIRSHIPS IN WAR AND PEACE"

Professor Lowe now has in an advanced state of preparation his absorbing and thrilling work, "My Airships in War and Peace." General Greeley, in generous fashion, referred to his accomplishments in the field of aeronautics in an interesting article published in Harper's Magazine, for June, 1900, which opens up a page in the War History of the United States before only briefly and inadequately touched upon.

Professor Lowe entered South Carolina eight days after the firing on Fort Sumpter, and accumulated valuable information for which he was thanked by the President.

As the Chief of the Aeronautic Corps, Professor Lowe was in intimate touch with many of the great men of the Nation, including President Lincoln and many commanders of the United States Army.

He repeatedly visited Lincoln, spending the night in the White House, and was first to convince the President that his call for 75,000 men was too small.

In the pages of this work he convincingly shows that the first great battle for the preservation of the Union—that of Bull Run—should have been a victory instead of a defeat for the federal forces, and gives the reasons why.

General Greeley says: "Professor Lowe saved the day at Fair Oaks and prevented the loss of thousands."

The Secretary of War asked Professor Lowe to make a special report to him of his work as Chief Aeronaut, and this report is being used as the basis of the new book.

This report shows that if reinforcements that were expected from Washington had been furnished, and had arrived at the right time, Richmond could easily have been taken, and the war probably ended at that early stage.

He will publish the telegrams sent from his War balloons to General McClellan, which other historians have only referred to, so that their importance will readily be discerned.

He was in close personal touch with General McClellan and other generals, and took active part in most of the battles of the early part of the war, making many ascensions a day, and even at night, to watch and report upon every movement of the enemy. Hundreds of thousands of shot and shell were aimed at him by the Confederates to destroy his ever-

present and watchful balloons, so that General Alexander and others of the Confederacy have agreed in affirming that the balloon corps of the U. S. Army, under Professor Lowe's efficient guidance, was worth all it cost, *even if it had never made a single observation,* because of the expense, loss and irritation entailed upon the South in hiding their operations from its vigilance.

Few people realize that the aeronautic corps was more exposed to the enemy's fire than any other branch of the army. Daily, and many a times a day, as the balloons ascended, were they subjected to the constant and determined fire of the foe. It is safe to affirm that greater endeavors were made to shoot Professor Lowe and his operators than any of the eminent generals, for there was scarcely a day that he was not made the target for the most vindictive shooting.

It can well be understood, therefore, that during his nearly three thousand ascensions, he had many thrilling, exciting and dangerous times, and as no account of these has ever yet been given, this feature of the book alone will be exceptionally interesting. The account will be detailed with truth and accuracy and as only the chief participator could give it.

He will also tell of the several attempts made by spies hired by the South to assassinate him and destroy his balloons while they were at rest at all costs, and his narrow escapes. He will relate how he several times came near being captured by the enemy and had many exciting adventures; how he planned to have his balloon float over the camps of the Southern Army, and having gained much useful information, to the untold chagrin of the enemy, and in spite of their endeavors to destroy him, he ascended to a higher current which bore him back to the federal lines and safety.

Several chapters are devoted to the inside history of a number of prominent military and naval officers and others, whose services have never yet been given proper recognition.

Startling inside facts are given showing that the defeat of Chancellorsville was unecessary.

Every page of this work will be interesting as the Aeronautic Corps was unique and performed such heroic service that it attracted the attention of all nations, and was especially appreciated by Prince de Joinville and his nephews, the Count de Paris and the Duc Du Chatres, who gave their services to the United States in this crisis with the same spirit that influenced Lafayette in the war of the revolution.

This work will also show the incalcuable good service the United States Signal Corps rendered the country during the Civil War. Next to the Aeronautic Corps its operators were more exposed to the enemy's fire than any other branch of the army, as some of them supplemented Professor Lowe's telegraphic messages from the air. The vast experience in the art of aeronautics gained by the Signal Corps in later years en-

titles the judgment and opinion of its officers to great credit and weight, as their familiarity with certain phases of the subject have prepared them to realize the tremendous possibilities and speedy probabilities of triumph in aerial navigation for military and naval purposes. The chapter devoted to the Signal Corps will be most instructive, interesting and revelative.

Equally fascinating with that portion of the work that deals with the use of the Lowe Airship in the Civil War, will be the portion that describes in detail, by picture and story, the uses to which the modern "Dreadnaughts of the Air" will be put. How will the airship be used in war? What can it accomplish? How will military and naval officers and men be trained to its uses? How war will be affected by this new factor of power will be graphically and vividly set forth.

Indeed it will be shown that the Lowe Planet Airship, used as a war weapon, will entirely change the future of civilization by rendering all land and sea warfare, as now waged, impossible. It is confidently prophesied that it will become the means of binding all civilized nations together in closer bonds of amity and brotherhood, by putting an end to the false glamour and glory, the horrors, and the devastation of war.

In addition to its uses in war, the many methods of using the Planet Airship for pleasure, exploring, commerce, freighting, etc., will be pictured and described.

A newly invented sea-going craft will be shown, possessing great speed and capacity, especially designed for the transportation of aircraft and supplies to different parts of the world, where they can cooperate with other aerial fleets.

A most interesting chapter will deal with the wonderful progress made by the United States in the past fifty years, and this will be compared with what may be confidently expected and anticipated in the next fifty years when the present expensive and cumbersome methods of transportation are changed for the new airship methods. In addition a forecast will be made of how the governments of the world will meet the new conditions brought about by aerial navigation.

ILLUSTRATIONS

The illustrations of this book will be commensurate with the importance of the subject. They show the Airship operations of the Civil War; Professor Lowe in the car of his War balloon sending telegrams to the commanding general and President Lincoln; balloons on vessels; the battles he engaged in; the great soldiers and statesmen he came in contact with, especially those who aided the cause of aeronautics; maps of battles; maps of his balloon trips; pictures taken from contemporary publications, Harper's Weekly, the daily papers, etc., in fact, no book of the day will be so sumptuously illustrated.

This, in brief, is a crude outline of what "My Airships in War and Peace" will contain. It will be a revelation to all readers, giving a view of the battlefields and their conflicts that no other person engaged in them

could possibly have. Hence it will be a book unique in the annals of warfare, and the like of which can never be written again, for war, as conducted during the Civil conflict, is already demonstrated to be a thing of the past.

"My Airships in War and Peace" will contain upwards of 700 pages, with 200 illustrations, and will be sold only by subscription.

AERIAL PUBLISHING COMPANY

522 Central Building. Los Angeles, Cal.

LETTER FROM PROFESSOR C. F. HOLDER

The following letter from Professor Charles F. Holder, the world-renowned sportsman and author, whose many books on hunting, fishing, etc., are acknowledged standards, writes the following enthusiastic words, after going over much of the material of this book:

Pasadena, Cal., October 1, 1909.

PROFESSOR T. S. C. LOWE.

DEAR SIR:—I have read the advance MS. sheets of your proposed book "My Airships in War and Peace," also your report as chief of the Aeronautic Corps of the U. S. to Secretary of War Stanton, and I am surprised that you have never given this to the public before, as you have, in my judgment, the material for a book that should be a brilliant success. Not only this, the subject, and your association with President Lincoln and all the great leaders of that time, your share in the great battles of the war, constantly under fire, as shown by your documents on file in the War Department, which I have seen, give the proposed book great and pre-eminent historical value.

I have presented the idea of this book to two of the largest and most influential publishers of the country in New York, and they will be glad to undertake its publication; but I would advise you not to let them have it on a percentage basis. It has such a promise of success that I advise you to pay them to publish it and thus control the entire proceeds of the book. Books of less value and interest have brought their authors fortunes.

While it is impossible to forecast its success, the eagerness of the publishers to get it suggests that the time is ripe, and I would push it to an early publishing in New York, and secure English, French and German editions.

Thanking you for permitting me to see the data and your report to the Secretary of War, a pleasure I have continued in the Century Company War Records, which shows you going into battle in your aerial war ship, "Intrepid," I am,

Very truly yours,

(Signed) CHAS. F. HOLDER.

INSTRUCTION

SUR LE

BALLON CAPTIF ALLONGÉ TYPE R

"R TYPE BALLOON"

Notice Approuvée par Décision Ministérielle
Du 13 Mars 1918

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

Première Partie

DESCRIPTION ET NOMENCLATURE

ENVELOPPE

Le Ballon Captif type R (fig. 1), a la forme d'une carène continue présentant dans le premier quart avant un maître-couple. Il mesure 28 mètres de longueur et 8 m. 50 de diamètre maximum. Son volume est d'environ 1000 mètres cubes.

L'enveloppe extérieure comporte les orifices suivants:

1° Une collerette de soupape située sur l'axe à l'avant (A);

2° Une manche de gonflement située à l'avant au-dessous de la collerette de soupape (B);

3° Deux regards en matière transparente permettant de surveiller l'intérieur du ballon et du ballonnet (CC');

4° Une pièce de passage pour la commande à main de la soupape;

5° Une pièce de passage pour la commande de déchirure;

6° Une pièce de passage située à l'arrière pour le réglage de la commande automatique de la soupape;

7° Une buse (D) destinée à mettre en pression le ballonnet. Cette buse est située à la partie inférieure du ballon, *en avant du*

Part I

DESCRIPTION AND LIST OF PARTS

ENVELOPE

The shape of the R type balloon (see fig. 1) is streamline with the beam situated in the first forward quarter. The total length is 28 metres and the beam 8 m. 30, the capacity is roughly 1000 cubic metres.

The envelope has the following apertures:

(1) A valve hole placed in the nose in the axis of the balloon (A).

(2) An inflating sleeve placed under the valve (B).

(3) Two windows of transparent matter for inspection of the balloon and ballonet from the outside (C, C').

(4) One cork hole for hand operated valve cord.

(5) One cork hole for ripping cord.

(6) One cork hole for regulating length of automatic valve cord at the stern.

(7) A scoop (D) for giving air pressure to the ballonet. This scoop is placed under the balloon, *forward of the beam,* in the zone

maître-couple, c'est-à-dire dans la zone de pression maximum du vent sur l'enveloppe.

BALLONNET

Le ballonnet, situé à l'avant du ballon, lui permet de conserver une forme invariable dès que le vent est notable, malgré les variations de volume du gaz hydrogène dans l'enveloppe. L'air du ballonnet est séparé de l'hydrogène par le diaphragme. L'air est mis en pression dans le ballonnet par la buse précitée. Une ouverture de communication équilibre la pression de l'air du ballonnet.

GOUVERNAIL

Le gouvernail (fig. 2) qui forme l'empennage est constitué par trois bourrelets pneumatiques. Chaque bourrelet est contreventé par une double corderie intérieure destinée à assurer sa permanence de forme en reliant sa surface extérieure à l'enveloppe.

Le bourrelet inférieur est gonflé par une buse inférieure (D'); il communique avec le ballonnet par l'orifice dont il a été parlé plus haut et avec les deux bourrelets supérieurs par deux manches de gonflement (E).

Des manches spéciales de dégonflement (F) sont ménagées dans les bourrelets supérieurs pour en permettre le dégonflement en campement ou sous le hangar.

Les dimensions de ces communication (E et F) permettent le passage d'un homme pour la visite et le réglage.

where the wind pressure on the envelope is the greatest.

BALLONET

The ballonet placed forward in the balloon ensures the balloon retaining its shape in a sufficient wind and independently of any variation in the volume of the hydrogen contained in the balloon. A diaphragm separates the balloon from the ballonet. The air pressure in the ballonet is maintained by the above mentioned scoop and an aperture communicating with the rudder equilibrates the pressure.

RUDDER

The rudder (fig. 2) is composed of three fins filled with air. Each one of these fins is strengthened by a double interior rigging—this ensures the perfect shape of the fin by maintaining a correct distance between the surface of the fin and the envelope.

The lower fin is inflated by a scoop (D') placed at its lowest part—a communication with the 2 upper fins is ensured by two inflation sleeves E.

Two deflating sleeves (F) are provided on the upper fins to allow their deflation when the balloon is bagged down or put in a shed.

These sleeves are sufficiently large to allow a man to enter the fins for inspection and for regulating the rigging.

SOUPAPE

La soupape (fig. 3) est placée à l'avant du ballon, son clapet est commandé automatiquement par le diaphragme du ballonnet, par l'intermédiaire des deux cordes suivantes:

1° La corde longitudinale de soupape qui relie le fond du clapet au pôle postérieur, en traversant le ballon dans sa longueur; elle est fixée à l'enveloppe, dans la région du pôle arrière, par un cône à 8 cordes partant d'une ralingue circulaire.

2° Une corde verticale de 1 m., attachée au premier tiers avant de la corde longitudinale de soupape; le bout inférieur de cette corde est relié au diaphragme par un cône à 8 cordes, formant à son sommet une boucle et assemblé à sa base par une ralingue circulaire fixée au diaphragme.

Lorsque le volume du gaz tend à croître, le diaphragme est refoulé; un peu avant de s'appliquer sur l'enveloppe, il exerce sur la corde verticale une traction qui se transmet à la corde longitudinale de soupape et par suite au clapet.

Lorsque la traction cesse, le clapet est rappelé par les ressorts.

Grâce à ce dispositif la corde longitudinale de soupape exerce toujours sur le clapet des efforts sensiblement normaux à son plan. Cette corde est réglable à son extrémité arrière, pour le cas ou l'étoffe du ballon varierait de longueur. A cet effet, elle tra-

VALVE

The valve (see fig. 3) is placed in the bow of the balloon. The valve plate is operated automatically by the diaphragm of the ballonet by the two following cords:

(1) A longitudinal cord extending all the length of the balloon from the valve plate to the stern—a cone of 8 ropes coming from a circular rigging edge joins the valve cord to the stern of the balloon.

(2) A vertical cord (1 m. in length) made fast to the 1st cord at a point placed at 1/3 of its total length from the valve. The lower end of this cord is looped to the summit of a cone of 8 ropes coming from a circular rigging edge fixed on the diaphragm.

When the gas in the balloon is dilated, the diaphragm is forced down; before coming into perfect contact with the envelope, a pull on the vertical cord takes place which is transmitted to the longitudinal valve cord and thus the valve plate is automatically operated.

When the pull ceases, the valve springs bring the plate back into place.

With this disposition, the valve cord has always a practically direct pull on the valve. The length of this cord can be regulated from the stern—in the case of the cord stretching or of the balloon fabric varying in length. For this purpose, the valve cord

verse le pôle arrière du ballon, où elle est arrêtée par une tête de turc butant sur une cosse.

SUSPENSION

On distingue dans le ballon captif type R deux suspensions (fig. 4 et 5):

a) la suspension de traction qui relie le ballon au câble,

b) la suspension de nacelle qui relie le ballon à la nacelle.

Toutes deux partent d'une même ralingue et sont formées de régimes de pattes d'oie dont tous les éléments sont interchangeables.

a) Suspension de traction

La suspension de traction (fig. 4 et 6) comprend 4 câbles métalliques (xx', yy'), deux à droite, deux à gauche partant du point de réunion de deux groupes de pattes d'oie situées de chaque côté. Chacun des 4 câbles aboutit à un anneau cosse; les 4 anneaux cosses sont réunis au câble d'ascension au moyen d'une pièce de jonction.

b) Suspension de nacelle

La suspension supérieure (fig. 4) comprend de chaque côté du ballon 4 groupes de pattes d'oies (*a', b', c', d'*, à droite, *a', b', c', d'*, à gauche) permettant à volonté l'arrimage d'une seule ou de deux nacelles.

Dans le cas d'une seule nacelle, des 6 groupes de pattes d'oie, *bb'* — *cc'* — *dd'* partent 6 suspentes en corde n° 1; dans le cas

goes through the stern of the balloon and is stopped by a turks head resting on an thimble.

RIGGING

The "R" balloon has two sets of rigging (see fig. 4 et 5):

(*a*) One set of rigging from balloon to cable (cable suspension).

(*b*) One set of rigging from balloon to basket (basket suspension).

Both sets are fixed unto one rigging band and are formed of two sets of bridles. Each piece of rope is of standard length and interchangeable.

a) Cable suspension

Is composed of 4 steel cables (xx', yy'), 2 on the right side, 2 on the left side, starting from the point of junction of 2 groups of bridles placed on either side. Each of these cables carries a ring; these 4 rings are joined on to the winch cable by a junction piece (see fig. 4 et 6).

b) Basket suspension

The upper suspension (see fig. 4) is composed on either side of the balloon of 4 groups of bridles: a, b, c, d, on the right side; a' b' c' d', on the left side allowing at will the use of one or two baskets.

For using one basket only, 6 suspension guys (corde n° 1) start from the six following sets of bridles bb', cc', dd', — For

de deux nacelles des 6 groupes *aa'* — *bb'* — *cc'* partent les 6 suspentes en cordeau n° 5 pour la nacelle avant, et des 6 groupes *bb'* — *cc'* — *dd'* partent six suspentes en cordeau n° 5 pour la nacelle arrière.

using two baskets, 6 suspension guys (cordeau n° 5) start from the 6 sets of bridles aa', bb', cc', for suspending the forward basket and 6 other suspension guys (cordeau n° 5) start from the 6 sets of bridles bb', cc', dd', for suspending the rear basket.

La suspension inférieure (planche 5) comprend 4 cordes sans dispositif de réglage, partant des quatre cabillots de nacelle, se réunissant 2 par 2 aux extrémités d'une barre d'écartement et aboutissant finalement à un cabillot supérieur (n° 14) unique où arrivent les deux boucles des suspentes milieu.

Aux deux extrémités de la barre d'écartement sont fixés deux V en cordeau n° 5 portant deux cabillots d'attache, un a l'avant pour les suspentes avant, un à l'arrière pour les suspentes arrière.

Aux deux extrémités de la barre sont en outre fixées deux cosses pour le réglage des balancines de roulis.

Les deux balancines de roulis sont formées de deux amortisseurs en forts ressorts de caoutchouc.

The lower basket suspension (see fig. 5) is composed of 4 ropes, with no regulating device, going from the 4 basket toggles and joined up 2 by 2 at the ends of a distance bar, finally bearing a single upper toggle (n° 14) and from this toggle looped to the 2 middle suspension guys.

Two Vs (cordeau (n° 5) with two toggles, one for the forward suspension guys, one for the rear suspension guys, are made fast to both ends of the bar.

Two thimbles are fixed to the ends of the bar for regulating the balancing shock absorbers. These are made of two strong rubber springs.

MONTAGE DES SUSPENSIONS

Pour éviter toute difficulté dans l'assemblage des cordages, les divers éléments de la suspension se distinguent au moyen de transfils bleus, rouges ou blancs (Fig. 4 et 6).

ASSEMBLING THE RIGGING

To make the rigging easier to assemble, blue, red and white whippings have been whipped round the different ropes (see fig. 4 et 6).

a) Suspension à deux nacelles

Les transfils sont bleus pour la suspension de la nacelle avant, ils sont rouges pour la suspension de la nacelle arrière.

Les boucles terminant les régimes de pattes d'oie portent un, deux ou trois transfils selon qu'il s'agit d'aboutir aux, suspentes avant, milieu, ou arrière des nacelles.

Les suspentes portent les mêmes signes (couleur et nombre des transfils) que les régimes avec lesquels elles sont bouclées.

b) Suspension à une nacelle

Les suspentes sont transfilées en blanc:

Un transfils pour la suspente avant, deux transfils pour la suspente milieu, trois transfils pour la suspente arrière.

Pour passer de la suspension à une nacelle à la suspension à deux nacelles, il suffit d'enlever de chaque côté les trois suspentes à transfils blancs et de réunir les suspentes rouges et bleues aux régime ayant les mêmes transfils.

Pour passer de la suspension à deux nacelles à la suspension à une nacelle, il suffit d'enlever les suspentes rouges et bleues et de fixer les suspentes blanches sur les régimes ayant le même nombre de transfils blancs.

FILET DE CAMPEMENT

Un filet de sangles à larges mailles destiné à faciliter le campement est collé sur la partie supérieure du ballon et porte sur la partie extérieure des anneaux

(a) Double basket suspension

Blue whipping is used for the forward basket suspension, red for the rear basket suspension. One, two or three whippings are fixed to the loops ending the sets of bridles, one corresponding to the forward, two to the middle, three to the rear suspension guys.

The suspension guys bear the same signs (colour and number of whippings) as the sets of bridles to which they are toggled.

(b) Single basket suspension

The suspension guys are whipped in white; one for the forward, two for the middle, three for the rear suspension guy. To change over from the single to the double basket suspension, take off on each side the three suspension guys marked in white and join the red and blue suspension guys to the sets of bridles bearing the same marks.

To change over from the double to the single basket rigging, take off the red and blue suspension guys and fix the white suspension guys to the sets of bridles bearing the corresponding number of white whippings.

BALLOON NET

A net made of large mesh webbing is stuck to the top of the balloon, thus making it easier to bag down. Metal rings with ropes are fixed to this net; to

métalliques munis de cordeaux. Ces cordeaux permettent de fixer les cordes de campement (fig. 7).

Le filet comporte seize anneaux correspondant à seize cordes de campement réparties sept sur chaque flanc du ballon, une à l'avant, une à l'arrière.

these are attached the picketing guys (see fig. 7.)

There are 16 rings and 16 guys, 7 on each side, 1 on the bow, and one on the stern of the balloon.

NACELLE

Les nacelles prévues pour l'arrimage à deux nacelles présentent les dimensions intérieures suivantes:

Longueur	1m05
Largeur	1m75
Hauteur	1m05

Le poids d'une nacelle de ce type est de 26 kgs.

Pour l'arrimage à une nacelle il peut être employé, soit l'une des nacelles précédentes, soit une nacelle carrée présentant les dimensions intérieures suivantes:

Côté	1m05
Hauteur	1m05

Le poids d'une nacelle de ce type est de 32 kgs.

Les nacelles des deux types sont munies de quatre cabillots seulement (*cabillots d'angle*).

BASKET

For the use of two baskets, the baskets used are as follows:

Length	1m05
Width	0m75
Height	1m05

The weight is then 26 kilos for each.

For the use of one basket, one of the above baskets may be used or a square shaped basket as follows:

Side	1m05
Height	1m05

The weight is then 32 kilos.

Both types of baskets are provided with only 4 toggles (one in each corner).

CORDES DE MANŒUVRE

Les cordes de manœuvre (fig. 4) sont au nombre de 5 de chaque côté, savoir:

3 à l'avant (l l′ l″) fixées dans les trois estropes terminant la suspente métallique avant de traction, une au milieu (*m*) au point de départ de la suspente métallique arrière de traction, une à l'arrière (*n*) au point de départ de la suspente milieu de la nacelle unique.

HANDLING GUYS

There are 5 handling guys (see fig. 4) on each side as follows:

3 at the bow (l, l′, l″) made fast in the 3 eyes ending the forward metallic guy of the cable suspension; 1 in the middle (m) at the start of the stern metallic guy of the cable suspension; 1 at the stern (n), fixed at the start of the middle guy of the single basket suspension.

COMMANDE DE SOUPAPE

En outre de son fonctionnement automatique, décrit ci-dessus, la soupape peut être également manœuvrée à la main. A cet effet, une commande directe de soupape en cordeau de chanvre écru descend de la soupape à la nacelle en traversant l'enveloppe dans un bouchon spécial.

COMMANDE DE DÉCHIRURE

Une commande de déchirure en tresse rouge descend à la nacelle. Le panneau de déchirure (*k*) arraché découvre des couvertures elliptiques par lesquelles se produit l'échappement du gaz. Ce dispositif assure à l'enveloppe une résistance égale en tous ses points, même à l'emplacement de la déchirure.

Par mesure de précaution un dispositif de sécurité (*pince et anneau*) greffé près des bouchons des commandes de soupape et de déchirure ne permet la manœuvre qu'après un premier effort brusque (15 kgs. environ). Deux efforts successifs sont donc nécessaires pour faire fonctionner l'une ou l'autre des deux commandes.

Des ressorts referment le clapet dès qu'on cesse de tirer sur la commande de soupape. La commande de déchirure ne doit être actionnée qu'à terre, après ascension libre et atterrissage, pour éviter le trainage par grand vent.

HAND OPERATED VALVE

The valve can be operated by hand as well as automatically, as described above. For this, a separate valve cord is made fast to the valve, goes through the envelope in a special plug and down to the basket.

RIPPING CORD

A red ripping tape goes down to the basket. A ripping panel R uncovers elliptical apertures through which the gas escapes. This device ensures an equal resistance to the envelope, even where the rip takes place. A safety device, ring and split ring, placed near the plugs of the valve and rip cords necessitates a strong jerk (about 15 kgs.) to allow the operation of either cord for which two pulls are thus necessary.

Springs close the valve when the pull on the valve cord ceases. The rip cord must only be operated on the ground after a free ascent and landing, to prevent the balloon being dragged in a strong wind.

Deuxième Partie.

GONFLEMENT

OPÉRATIONS PRÉLIMINAIRES

MONTAGE ET RÉGLAGE DE LA SOUPAPE

Comme il a été expliqué ci-dessus, un câble métallique de $2^{m}/^{m}5$ relie la soupape au pôle arrière du ballon, ce câble se termine à l'avant par une estrope en cordeau n° 3 qui se fixe à l'anneau du clapet par un nœud droit, obtenu en coiffant la soupape.

La soupape se monte sur le ballon au moyen d'écrous à oreilles en interposant un joint de caoutchouc entre le bois et l'étoffe.

La longueur de la corde de soupape qui commande automatiquement le clapet est réglée au moment de la construction, mais elle peut être réglée à nouveau en déplaçant le tête de turc qui s'appuie à l'arrière du ballon sur la cosse du cône des 8 cordes de la ralingue circulaire. Cette tête de turc peut sortir à l'extérieur grâce à un bouchon ménagé au centre de la ralingue circulaire en refoulant l'enveloppe vers l'intérieur; le réglage peut donc être fait facilement, même sur un ballon gonflé.

Part II

INFLATION

BEFORE INFLATING

FIXING AND TESTING VALVE

As mentioned above, the valve is joined to the stern of the balloon by a metal cable 2 $^{m}/^{m}$ 5 in diameter. The forward end of this cable bears a loop (cordeau n° 3); this loop is passed through the ring of the valve plate and made fast to it by slipping the valve through the loop.

The valve is fixed into the balloon by a series of thumbscrews; a rubber washer is inserted between the wood and the fabric. The correct length of cord for operating the valve is carefully determined in the making of the balloon, but this may be regulated afresh by displacing the turks' head placed at the stern. This turks' head forces against the thimble of the 8 rope cone of the circular rigging edge. It can be pulled out of the balloon through a plug hole left in the centre of this circular piece, the envelope being slightly pushed in first.

Lors de la construction, le réglage est obtenu par la confection de toutes les cordes sur gabarit et la vérification par le gonflement à l'air.

Lorsque le ballon est en service, il y a lieu de s'assurer fréquemment du bon fonctionnement de la soupape en la faisant ouvrir par un renflouement suffisant, le ballon étant soulevé au-dessus de son campement.

With this device, it is quite easy to regulate the valve cord even on an inflated balloon.

The correct working is ensured in the making of the balloon by each rope being cut to standard length and the balloon being tested with air.

When the balloon is in use, it is necessary to frequently test the correct working of the valve by topping up sufficiently the balloon lifted off its bed.

CONFLEMENT PROPREMENT DIT

Etendre le ballon sur deux bâches de gonflement ordinaires, mises bout à bout. Orienter les bâches pour que le ballon soit placé dans le lit du vent, l'avant frappé par le vent.

Fixer quelques cordes de campement aux piquets correspondants (voir *campement*).

Disposer les sacs de lest (85 *au minimum*) tout autour de la ralingue, en les accrochant au premier rang des pattes d'oie.

Introduire le gaz dans le ballon.

Au début du gonflement et s'il y a du vent au campement, limiter les mouvements de la bulle gazeuse en gonflant tout d'abord l'avant et en formant barrage par des aérostiers couchés transversalement vers le milieu; ce barrage sera peu à peu déplacé vers l'arrière.

N'arrêter l'arrivée du gaz qu'après s'être assuré du fonctionnement automatique de la soupape.

INFLATING THE BALLOON

Spread the balloon on two ground sheets placed lengthwise and in such a manner that the wind should strike the bow of the balloon.

Tie a few picketing guys to the corresponding pickets (see bagging down). Hook about 85 sandbags all round the rigging band to the first row of bridles.

Let the gas into the balloon.

When starting to inflate, especially if there is any wind, fill the bow of the balloon first. Balloon hands should lie across the balloon and move slowly back towards the stern.

Do not stop inflating before making sure of the automatic working of the valve.

RENFLOUEMENT

La manche à l'avant permet le renflouement du ballon au campement par la seule équipe de garde, il suffit de desserrer les cordes de campement au fur et à mesure de l'arrivée du gaz.

Le renflouement s'arrête dès que les sacs de lest tendent à quitter le sol.

Cette condition étant aussi celle qui assure au ballon la plus grande stabilité du campement, le renflouement devra être effectué autant que possible chaque soir.

De temps à autre, effectuer un renflouement complet pour vérifier la soupape.

TOPPING UP

The inflating sleeve placed in the bow allows the balloon to be topped up by the party on guard alone. The picketing guys should be slackened as the topping up is being carried out.

Stop topping up when the sandbags are about to leave the ground. This being the safest and most stable position for the balloon when bagged down, the balloon should be, if possible, topped up every evening.

From time to time a complete topping up should be carried out to test the valve.

Troisième Partie

CAMPEMENT.—ENTRETIEN DU MATÉRIEL

Le ballon doit être amarré au campement, si possible, de manière que l'avant soit frappé par le vent, les sacs de lest répartis autour de la ralingue, les cordes de campement attachées à leurs piquets.

Le ballon est renfloué jusqu'à ce que le tiers des sacs environ soit soulevé du sol, le gaz est ainsi légèrement en pression et sa force ascensionnelle reste bonne.

La bâche servant au campement est une bâche légère de 30 × 10 m.

L'air du ballonnet doit s'échapper par l'ouverture qui le fait communiquer avec le gouvernail.

L'air du gouvernail s'échappe par la buse inférieure et par les orifices spéciaux.

La soupape est coiffée de sa calotte.

Le ballon, étant assis sur le sol, est amarré solidement par les cordes de manœuvre aux piquets de campement à raison d'une corde par piquet.

Dans le cas d'un sol très mou, enfoncer des longs piquets de bois en grume de fort équarissage, taillés sur place, retenus au besoin à leur tête par un cordage fixé à un deuxième piquet à l'arrière.

Part III

BALLOON BED.—UPKEEP OF PARTS

The balloon should, when possible, be bagged down bow to the wind, the sandbags spread along the rigging band and the picketing guys tied to the pickets.

The balloon should be topped up until about a third of the sandbags leave the ground, there is then a slight gas pressure and the lift of the balloon remains satisfactory.

The ground sheet for bagging down is a light sheet $30^{m} \times 10^{m}$.

The air from the ballonet should escape through the communication hole into the rudder.

The air in the rudder escapes by the special apertures.

The valve is covered by a cap.

The balloon, on the ground, is firmly held by the handling guys tied to the pickets (one guy per picket).

In soft soil, plant strong posts cut from rough timber, tied if necessary at the top to a 2nd post farther back.

Les bois en grume par leurs aspérités, leurs nœuds, adhérent beaucoup mieux aux sols mous que tous les autres piquets; par leur grande surface d'appui ils offrent une plus grande résistance aux efforts horizontaux.

Dans les terrains de consistance moyenne, les piquets métalliques tire-bouchons sont les meilleurs.

En cas de grands vents, les sacs de lest seront amarrés à une corde n° 2 formant ceinture autour du ballon à raison d'un sac sur deux ou trois.

La corde de ceinture sera retenue par des piquets, sur les flancs, à l'avant et à l'arrière du ballon.

Timber with bark holds better in the ground than any other post on account of the roughness and of the knots. These posts stand a horizontal pull better than any other thanks to their large diameter. In fairly hard soil the iron corkscrew pickets are the best. In strong winds a belt (corde n° 2) should be provided and one sandbag out of two or three should be hooked to it.

This belt should be made fast to pickets on the sides, bow and stern of the balloon.

ENTRETIEN DE LA SOUPAPE

Au campement, vérifier le bon fonctionnement du clapet et graisser légèrement les articulations métalliques, éviter les projections de matière grasse sur le caoutchouc.

UPKEEP OF VALVE

When the balloon is bagged down, test the correct working of the valve plate, oil the rocking levers slightly; be careful not to drop any oil on the rubber.

ENTRETIEN DE LA CORDERIE

Le ballon R a été spécialement étudié pour permettre un entretien facile de la corderie. A cet effet, celle-ci a été décomposée en un petit nombre d'éléments simples, rigoureusement interchangeables et faciles à démonter.

Si un élément présente les marques d'une usure notable, il peut être remplacé le soir au campement.

La caisse d'accessoires contient un grand nombre d'éléments de corderie. Chaque élément, dès qu'il a été utilisé sur le ballon,

UPKEEP OF RIGGING

The "R" balloon has been designed specially to render the upkeep of the rigging very simple. There are but a small number of parts of equal lengths, absolutely interchangeable and easy to take down.

Any part showing signs of wear can be changed in the evening when the balloon is bagged down. The riggers' box contains a great number of these parts. Any part taken from the box should be at once replaced by one made up fresh. If any part

doit être remplacé dans la caisse par un élément nouvellement fabriqué.

En cas d'allongement d'un élément, la longueur supplémentaire sera partagée entre les deux brins proportionnellement à leur longueur primitive (voir *le dessin de la suspension*).

La corderie du ballon R, ainsi maintenue constamment en parfait état, ne doit jamais avoir besoin d'un remplacement total et assure une complète sécurité aux observateurs.

has stretched, the extra length should be diminished proportionally to the length of each side (see diagram of rigging).

If the rigging of an "R" type balloon is properly watched, there should never be any need of a complete new rigging and the observers should enjoy a complete safety.

Quatriéme Partie

MANŒUVRE ET ARRIMAGE CAPTIF

En attendant le règlement de manœuvre en préparation, on se guidera sur les indications suivantes:

COMPOSITION DES ÉQUIPES

1 Officier Chef de manœuvre.

BRIGADE DES SERVANTS

1 Sergent chef de brigade.
2 équipes de cordes de manœuvre avant, chacune d'elles comprenant 1 caporal et 15 hommes (5 par corde).
Total: 2 Caporaux, 30 Hommes.

2 équipes de cordes de manœuvre milieu, chacune d'elles comprenant 1 caporal et 5 hommes.
Total: 2 Caporaux, 10 Hommes.

2 équipes de cordes de manœuvre arrière, chacune d'elles comprenant 1 caporal et 5 hommes.
Total: 2 Caporaux, 10 Hommes.

Total general:

1 Sergent, 6 Caporaux, 50 Hommes.

BRIGADE DES ARRIMEURS

1 Sergent chef de brigade.
Equipe de nacelle: 1 caporal et 4 arrimeurs.
Equipe des accessoires (déchirure, soupape, gouvernail): 4 hommes.
Total: 1 Sergent, 1 Caporal, 8 Hommes.

Le ballon étant campé, arrimer la nacelle et mettre le ballon au cable.

Détacher les cordes de campement.

Part IV.

MANŒUVRING AND RIGGING THE BALLOON FOR ASCENT

Awaiting a new official text book on personnel and manœuvring, these are the rules to be followed:

BALLOON CREW

1 Officer in Command.

BALLOON PARTY

1 Sergeant in command.
2 Crews for forward handling guys, each 1 Corporal and 15 men (5 per guy).

Total: 2 Corporals, 30 Men.

2 Crews for middle handling guys, each 1 Corporal and 5 men.

Total: 2 Corporals, 10 Men.

2 Crews for stern handling guys, each 1 Corporal and 5 Men.

Total: 2 Corporals, 10 Men.

General total:

1 Sergeant, 6 Corporals, 50 Men.

RIGGERS

1 Sergeant in command.
Basket riggers: 1 Corporal and 4 riggers.

Different parts: Rip cord, Valve, Rudder riggers, 4 Men.
Total: 1 Sergeant, 1 Corporal, 8 Men.

Taking the balloon from the bed, rigging the basket and attaching to winch cable.

Unfasten picketing guys.

Disposer les équipes de servants aux cordes de manœuvre. Ces équipes se mettent immédiatement dans la position de "Tenez ferme," le caporal qui commande l'équipe prend la corde située le plus à l'avant avec les hommes du 1er rang; la 2e corde est tenue par les hommes du 2e rang.

Faire descendre les sacs de lest par l'équipe de réserve, ou, à défaut, par les nos 3 et 4 de chqaue corde.

Laisser aux points d'attache de la suspension de traction et des suspentes de nacelle un total de 40 sacs au maximum. Ce nombre doit être réduit jusqu'à 25 quand le ballon n'est pas complètement gonflé.

Au fur et à mesure de la descente des sacs, laisser monter aux cordes de manœuvre.

Les arrimeurs, chargés des accessoires, fixent alors les suspentes métalliques de traction et en réunissent les extrémités inférieures dans la boucle de jonction.

Les arrimeurs, chargés de la nacelle, mettent en place les balancines de roulis en les cabillotant à la partie supérieure de la suspente milieu de la nacelle.

L'arrimeur, chargé des cordes de déchirure et de soupape, se tient sur le flanc gauche du ballon et fixe la tresse de déchirure par un fil à casser au point d'attache de la suspente avant de la nacelle.

Faire détacher les sacs de lest et laisser monter le ballon.

Place the handling guy crews at their guys. They take up the position of "Hold fast" on two rows, the corporal takes the forward handling guy with the men of the first row, the second row take up the second guy.

The reserve crew lowers the sandbags, or if there is no reserve crew, the number 3 and 4 of each handling guy.

Leave a maximum of 40 sandbags at the points of junction of the cable suspensions and of the basket suspension; 25 bags will be sufficient if the balloon is not quite full.

As the bags are lowered, allow the balloon to rise on the handling guys.

The riggers in charge of the different parts fix the metallic suspension guys and join them up to the junction piece. The basket riggers attach the balancing shock absorbers by toggling them to the upper part of the middle basket suspension guy.

The rigger in charge of the rip and valve cord stands on the left side of the balloon and ties the cords with an easy breaking thread to the starting point of the forward basket suspension guy.

Take off the sand bags and let the balloon up.

Quand le ballon est à 2 mètres du sol, amener la nacelle et sa suspension, coiffer le gros cabillot par les boucles des suspentes milieu, les cabillots des V avant et arrière de la suspension de nacelle par les boucles des suspentes correspondantes.

Laisser monter doucement jusqu'au point où la nacelle quitte le sol. Passer chacune des balancines de roulis dans la cosse correspondante située à l'extrémité de la barre de nacelle. En régler la tension et fixer chaque balancine à l'extrémité de la barre opposée à la cosse de réglage. Chaque balancine doit tirer un peu moins de 10 kg.

Amarrer à la barre de nacelle, en leur laissant suffisamment de mou, les cordes de soupape et de déchirure.

Approcher le ballon, le tenir aux cordes de manœuvre à proximité du treuil, le ramener un peu pour permettre aux arrimeurs de passer la boucle du treuil dans la pièce de jonction.

Laisser monter le ballon et larguer.

When the balloon is 2 metres off the ground, bring up the basket and its suspension, pass the loop of the forward guys over the large toggle and the loops of the other suspension guys over their corresponding forward and rear toggles.

Let up till basket leaves the ground. Pass each balancing shock absorber through the corresponding thimble placed at the ends of the basket bar. Adjust the tension and tie each of these balancing guys to the end of the bar opposite its adjusting thimble. The tension should be slightly inferior to 10 kilos.

Tie the valve and rip cords to the basket bar leaving plenty of slack. Bring the balloon up to the winch, lower it slightly with the handling guys so as to allow the riggers to pass the loop at the end of winch cable into the junction piece.

Let the balloon up by hand and on the winch.

CHARGE DE LA NACELLE

La nacelle doit porter au moins 80 kg., au plus 200 kg.

WEIGHT IN BASKET

Should not be less than 80 kilos and not over 200 kilos.

MANŒUVRE AUX TIRAUDES

Dans cette manœuvre, les équipes arrière passent les premières des tiraudes aux cordes de manœuvre, les dernières des cordes de manœuvre aux tiraudes.

MANŒUVRING WITH SPIDER

For this, the rear handling guy crews are the first to go from their guys to the spider, and the last to go back from the spider to their guys.

TRANSPORT À BRAS AUX CORDES DE MANŒUVRE

Le ballon se transporte à bras aux cordes de manœuvre sans suspension de nacelle. Laisser des sacs aux points d'attache comme il est dit plus haut.

Dans ces transports, le ballon doit être constamment maintenu orienté dans le lit du vent, la pointe en avant, face au vent. Quand le ballon est muni de la nacelle, chargée de 120 kg., les équipes milieu et arrière ne doivent pas exercer d'effort sur les cordes de manœuvre, elles doivent suivre le ballon, qui s'oriente automatiquement au vent, en modérant seulement les oscillations.

WALKING THE BALLOON WITH THE HANDLING GUYS

The balloon is walked with no basket, leaving sandbags as is said above.

The balloon must always be kept bow on to the wind.

If the basket with 120 kilos of weight is attached to the balloon the middle and stern handling guy crews should not pull on their guys; they will simply follow the balloon which automatically will keep bow on to the wind, and they will only check the oscillations.

POIDS DU MATÉRIEL BALLON R

(1.000 mc.)

Enveloppe munie de sa corderie	390k.000
Soupape	7 750
Suspension inférieure de nacelle	7 000
Cordes de manœuvre	22 000
Suspentes métalliques de traction	13 050
Nacelle	32 000
Imprévu	3 200
Total	475k.000

WEIGHT OF PARTS "R" TYPE BALLOON

(1,000 cubic metres)

Envelope and rigging	390k.000
Valve	7 750
Lower basket suspension	7 000
Handling guys	22 000
Metallic cable suspension guys	13 050
Basket	32 000
Extra	3 200
Total	475k.000

EFFORT DÛ AU VENT SUR LE BALLON R.

en kilogr. $= 1{,}00 \times V^2$

V en mètres par seconde.

TENSION DUE TO WIND ALONE ON SURFACE OF "R" TYPE BALLOON

in kilogr. $= 1{,}00 \times V^2$

V being metres of wind per second.

EFFORT SUPPLÉMENTAIRE PENDANT LA DESCENTE.

en kilogr. $= 70\ n$, n mètres de câble ramenés par sec.

Tenir compte, en sus, de la force ascensionnelle restante.

SUPPLEMENTARY TENSION DUE TO HAULING IN

in kilogr. $= 70$ n; n being metres of cable hauled in per second.

To this, of course, the lift should be added.

L'emploi du ballon étant lié étroitement à la mesure du vent, et surtout à la mesure de la tension du câble, la connaissance des deux annexes ci-jointes est indispensable.

For the correct use of the balloon it is most necessary to measure accurately the speed of the wind and the tension on the cable. Appendix 1 deals with the anemometer, appendix 2 with the tension meter.

Première Annexe

Notice d'emploi de l'Anémomètre électrique "Système Richard"

Cet appareil permet de recevoir à terre, au moyen de l'écouteur du poste téléphonique, la vitesse du vent transmise par un anémomètre installé à bord du ballon captif allongé.

I. Montage normal n'utilisant que le poste microtéléphonique de terre

1. INSTALLATION DE L'ANÉMOMÈTRE A BORD DU BALLON CAPTIF ALLONGÉ

1. Serrer, au moyen de deux écrous, le crochet de suspension en aluminium entre la plaquette mobile et la tige fixe de l'anémomètre.

2. Fixer chaque crochet du conducteur souple électrique aux bornes situées à la partie inférieure de l'anémomètre.

3. Accrocher l'anémomètre à la barre de suspension de nacelle en ayant soin de placer face au vent, la face avant de l'anémomètre.

(La face avant se reconnaît au profil en biseau que présente la tige verticale supportant le pivot du moulinet).

4. Relier les deux extrémités inférleures du cordon souple au câble téléphonique aboutissant à la nacelle; le poste téléphonique de nacelle étant complètement débranché (fig. 8).

Appendix I

Notes for Use of the Electric Wind Gauge "Richard"

This instrument allows of wind readings, being taken on the ground through the telephone apparatus by means of an anemometer placed in the basket.

I. Ordinary mounting utilizing the ground station only

1. FIXING OF APPARATUS TO BALLOON BASKET

(1) Secure the aluminium suspension hook between the plate and the rod of anemometer with 2 bolts.

(2) Fix each end of flexible wire to the terminals placed on lower side of anemometer.

(3) Hang the instrument to the basket bar, the forward edge of the instrument facing the wind.

The forward edge of the instrument is tapered and easy to recognize.

(4) Connect to the telephone wire, the telephone in basket being disconnected (see fig. 8).

CONNEXION AU POSTE DE TERRE
CONNECTION TO GROUND STATION

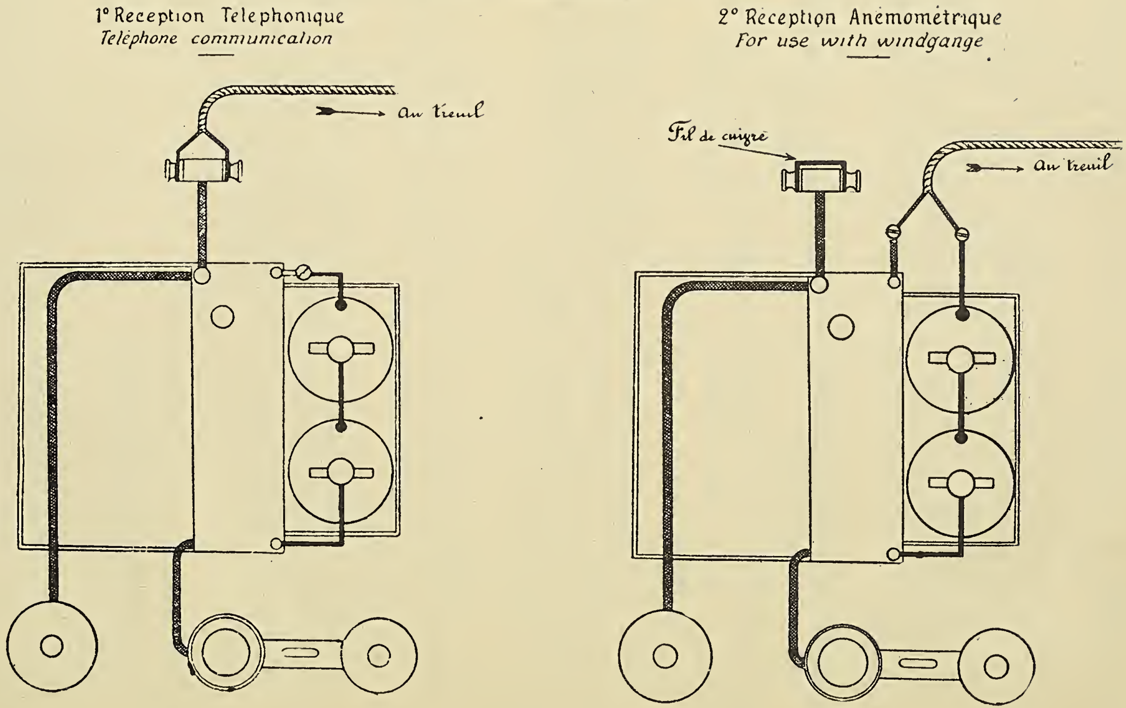


FIGURE 7

2. INSTALLATION DU POSTE TÉLÉPHONIQUE DE TERRE DESTINÉ À LA RÉCEPTION

Les connexions qui, dans le cas de réception téléphonique simple, sont indiquées par le schéma 1 de la fig. 8, doivent être modifiées comme il suit pour l'emploi de l'anémomètre (sch. 2).

1. Relier un des 2 conducteurs du fil souple venant du treuil à une des bornes de la pile; le 2. conducteur étant relié au cordon souple sortant de la boîte téléphonique.
2. Mettre en court-circuit, les 2 pôles de la borne de jonction.

3. ESURE DE LA VITESSE DU VENT

1. Se munir d'une montre à secondes.
2. Prendre en main l'écouteur téléphonique et en serrer la poignée.
3. Compter le nombre de contacts N entendus pendant un temps déterminé, 100 secondes par exemple.

Sachant qu'un contact correspond à 10 mètres de vent passés dans l'appareil, la vitesse V du vent en mètre par seconde est donnée par la formule:

$$V \text{ mt. seconde} = \frac{N \times 10 \text{ mt.}}{100''} = \frac{N}{10}$$

NOTA.—Ne jamais faire tourner l'anémomètre en agissant directement au moyen des doigts sur les pales du moulinet.

2. ARRANGEMENT OF CONNECTIONS OF TELEPHONE APPARATUS ON THE GROUND

Fig. 8 shows modifications of telephone to allow use of anemometer, schéma 2.

(1) Join one of the flexible cables to one of the terminals of battery—the other cable being joined to the cable coming from the telephone box.

(2) Short circuit the terminals of junction piece.

3. TAKING A WIND READING

(1) Take a stop watch.

(2) Take the telephone receiver and press the switch.

(3) Count the number N of contacts (tics) heard in a given period, say 100 seconds.

Each contact corresponds to the passing of 10 metres of wind through the instrument. Thus we get:

$$V \text{ (in metres per second)} = \frac{N \times 10^{m}}{100''} = \frac{N}{10}$$

NOTE.—Never turn the blades of anemometer with the fingers.

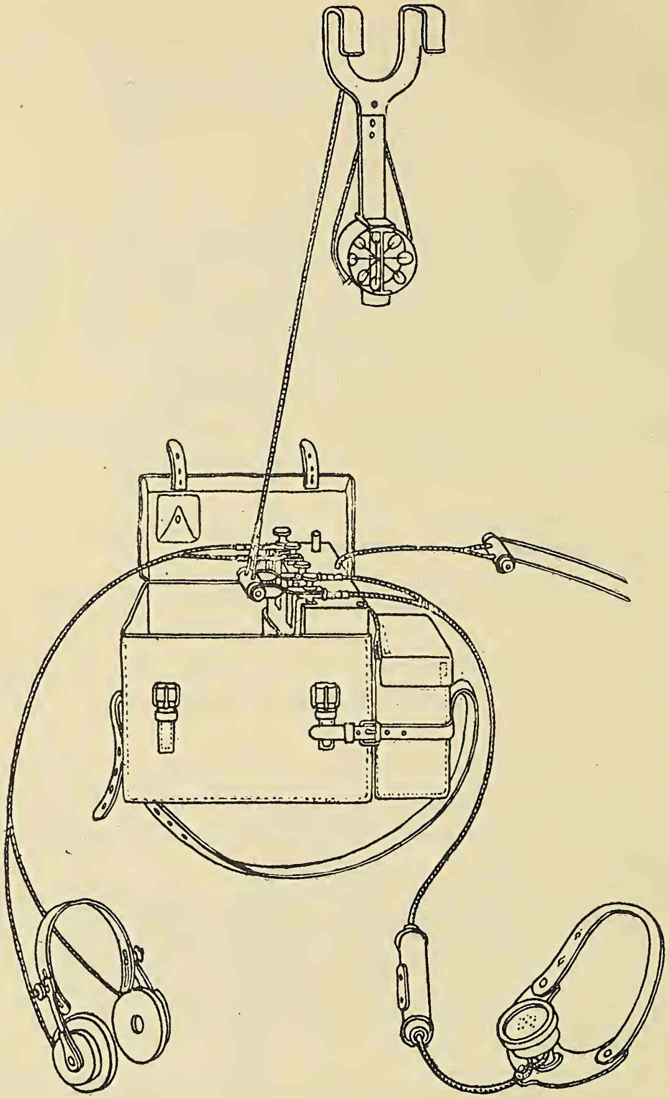


Figure 8

Installation dans la Nacelle

Fixing in Basket

II. Montage spécial, utilisant le poste téléphònique de nacelle, permettant de mesurer de terre la vitesse du vent sans interrompre les conversations téléphoniques

1. INSTALLATION DANS LA NACELLE

1. Installer dans la nacelle un poste téléphonique à casque d'écoute et plastron microphone (modèle 1914).

2. Le raccorder à la ligne téléphonique de nacelle.

3. Accrocher l'anémomètre à la barre de suspension de nacelle, comme il est dit plus haut.

4. Relier la borne de jonction terminant le fil souple de l'anémomètre *aux bornes du plastron microphone*, au moyen de 2 barrettes (fig. 8).

2. INSTALLATION DU POSTE TÉLÉPHONIQUE DE TERRE

Ne rien modifier.

3. MESURE DE LA VITESSE DU VENT

Ce montage permet d'écouter, soit du poste de nacelle, soit du poste de terre, les "tocs" de l'anémomètre, sans interrompre les communications téléphoniques entre la nacelle et le sol.

II. Mounting of apparatus allowing of wind readings being taken on the ground, without interrupting telephone communication

1. FIXING IN BASKET

(1) Use a head gear receiver and breastplate transmitter (model 1914).

(2) Connect to basket wire.

(3) Hang the anemometer to basket bar as said above.

(4) Connect the junction piece of anemometer to the 2 terminals of breastplate transmitter (*see* fig. 8).

2. GROUND STATION

No change.

3. TAKING A WIND READING

The wind readings may thus be taken without interfering with the conversation.

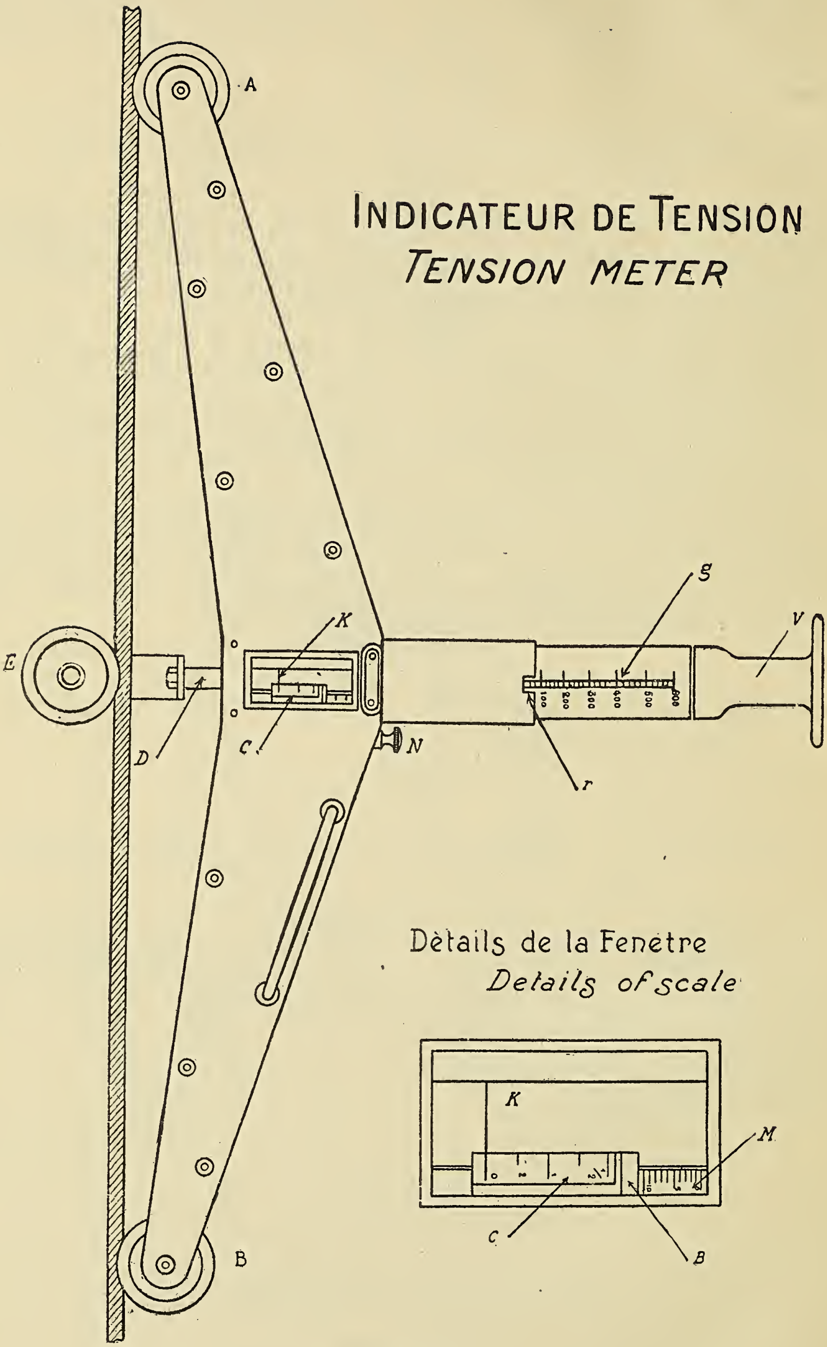

INDICATEUR DE TENSION
TENSION METER
A
E
D
K
C
N
g
V
r
B
Dètails de la Fenetre
Details of scale
K
M
C
B

FIGURE 9

Deuxième Annexe

INDICATEUR DE TENSION TYPE E POUR CABLES ET CORDAGES

(*Force 60 à 600 et 1200 kgs*)

Deux cas sont à considérer:

Premier cas.—Le diamètre du câble ou du cordage dont on cherche la tension est connu

1. Opération—Réglage initial

Déplacer le curseur C à l'aide du bouton moleté N de façon à faire coïncider le biseau B de ce curseur avec la division de l'échelle millimétrique M correspondant au diamètre du câble. (La figure ci-contre indique la position du curseur pour un câble de $11^{m}/^{m}$.)

2. Opération—Mesure de la tension

Placer l'indicateur sur le câble comme l'indique la figure. Tourner l'écrou V jusqu'à ce que le trait de repère K se soit transporté en face du trait 1 du curseur C.

S'assurer que cette opération est correctement exécutée en faisant rouler l'appareil sur le câble.

Lire en face de l'index *r*, sur la graduation *g*, la tension totale du câble exprimée en kilogrammes.

Si la tension du câble est supérieure à 600 kilogrammes, il suffira, pour avoir la tension totale

Appendix II

USE OF TENSION METER TYPE E FOR STEEL CABLES AND ROPES

(*Strength 60 to 600 and 1200 kgs*)

Two cases should be considered:

First case.—The diameter of the cable or rope is known.

1. Adjustment of the instrument

Move the sliding scale C with the milled screw N so as to bring the edge B against the figure of the scale M corresponding to the diameter of cable. (The figure shows the correct adjustment for a cable of $11\ ^{m}/^{m}$.)

2. Measuring the tension

Place the instrument on the cable as shown in the figure. Tighten the nut V until the line K is opposite the figure 1 on scale C.

Run the instrument up and down the cable to make sure that the measurement is correct.

Read on the scale *g* opposite the arrow *r* the tension on the cable in kilogrammes.

If the tension is higher than 600 kgs, bring the mark K opposite the fig. 2 of the sliding scale

du câble, de déplacer le trait de repère K en face du trait 2 du curseur et de multiplier par 2 le résultat de la lecture sur la graduation G.

Pour les tensions inférieures à 300 kilogrammes, il peut être avantageux d'amener le trait K en face de la division 1/2 du curseur. La tension cherchée s'obtient en multipliant par 1/2 le résultat de la lecture.

Deuxième cas.—Le diamètre du câble est inconnu.

1. Opération—Mise au zéro de l'indicateur

Desserrer l'écrou V d'une quantité suffisante pour que le câble, appuyé sur les gorges des galets A et B, ne touche pas la gorge intérieure du galet E.

En agissant à la main sur l'extrémité de la tige coulissante D amener le galet E au contact du câble. Le galet doit toucher le câble sans appuyer sur lui.

Déplacer alors le curseur C, à l'aide du bouton moleté N, de façon à amener la coïncidence entre le repère K de la tige coulissante et le trait O du curseur.

Dans cette position le biseau B du curseur indique sur l'échelle millimétrique M le diamètre du câble.

2. Opération—Mesure de la tension

Mêmes opérations que dans le premier cas.

REMARQUES IMPORTANTES

1. S'assurer avant de se servir de l'appareil que la tige coulissante D, qui porte le galet E, glisse librement dans ses guides. Huiler s'il y a lieu.

and double the reading given on scale G.

If the tension is lower than 300 kgs the reading may be taken as follows: Bring the line K opposite the figure 1/2 on the sliding scale—Halve the reading given on scale G.

Second case.—The diameter of the cable is not known.

1. Measuring the diameter of cable

Unscrew the milled head V sufficiently for the cable placed in the grooves A and B not to touch the inner groove E.

Push the gliding rod D so as to bring the wheel E in contact with the cable. This pulley must touch the cable but not press against it.

Move the scale C by turning the screw N so as to bring the line R on the rod opposite the line O on the scale.

The edge B will then be opposite the figure corresponding to the diameter of the cable in millimetres on scale N.

2. Measuring the tension.

The tension will then be measured as in the first case.

NOTE

1. Make sure that the rod B glides easily on its bearings; oil if necessary.

2. Pendant les mesures, l'appareil doit être tenu par la poignée ou par les flasques; la main qui agit sur l'écrou moleté V ne doit pas servir à maintenir l'appareil.

3. L'appareil doit être orienté de telle façon que la tige coulissante D soit sensiblement horizontale.

4. La précision de l'appareil est d'environ 1/20°.

2. When using the instrument always hold it by the flanges. Never hold it either by the handle nor by the milled head V.

3. The instrument must be held so as to keep the rod D horizontal.

4. The instrument is accurate to about 1/20 of the reading.

O

Figure 1

VUE D ENSEMBLE

GENERAL VIEW

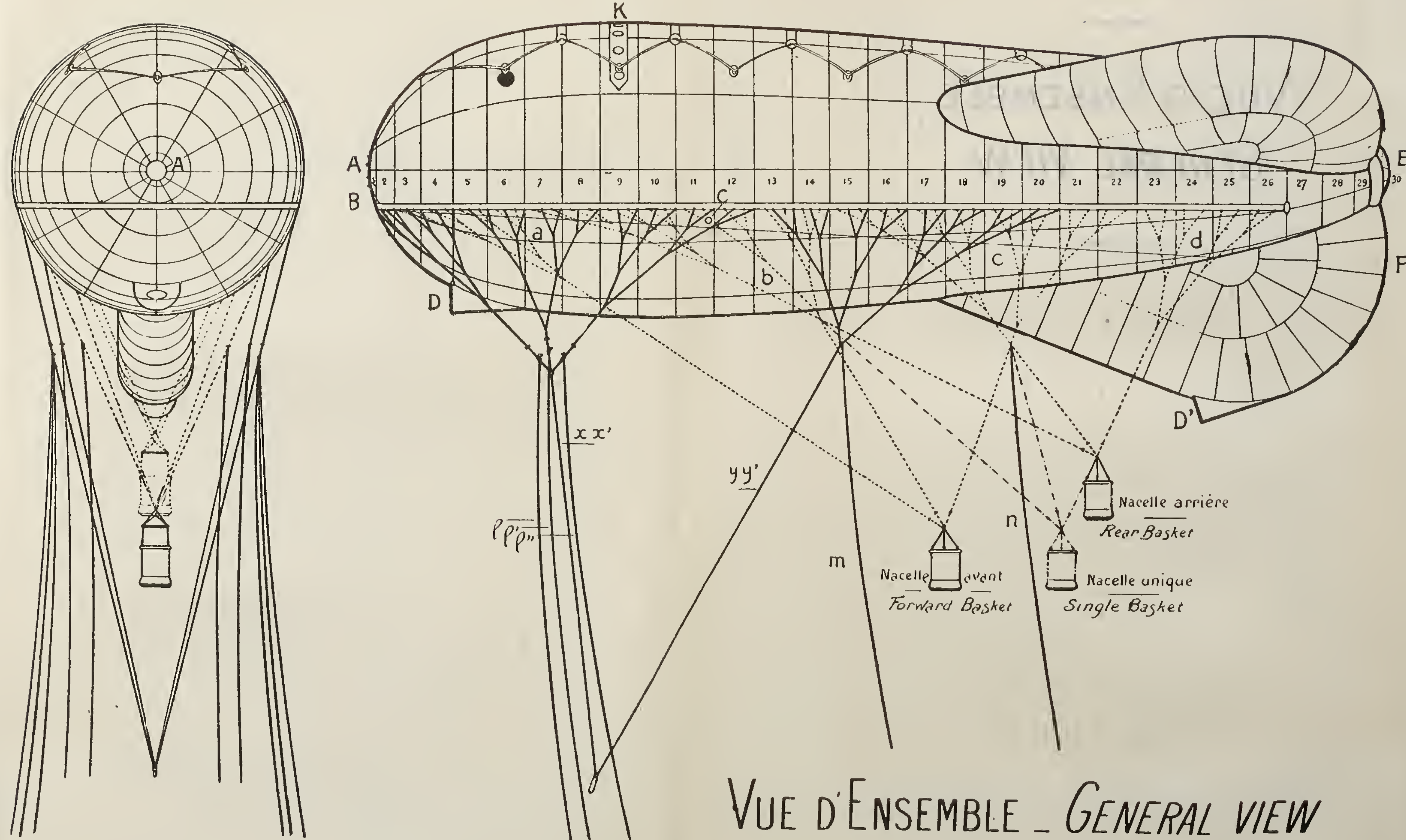
1 A

Ballon captif type R

LEGENDE

A Soupape. — *Valve.*
B Entrée de la manche de gonflement. — *Entrance of inflation sleeve.*
CC' Regards. — *Inspection windows*
D Buse du Ballonnet. — *Scoop of ballonet.*
D' Buse du bourrelet inférieur. — *Scoop of lower fin.*
E Manche de communication. — *Communication Sleeve.*
F Manche de dégonflement — *Deflation sleeve.*
xx' / **yy''** Câble métallique de la suspension de traction — *Metallic suspension guys for cable suspension.*
l m n Cordes de manœuvre. — *Handling guys.*
K Panneau de déchirure — *Ripping panel*

——— Suspension de traction. — *Cable suspension*
.... Suspentes de nacelle (avant et arrière). — *Forward and rear basket, suspension guys.*
-.-.-. Suspentes de nacelle milieu. — *Middle basket guys.*



VUE D'ENSEMBLE _ GENERAL VIEW

LEGENDE

A Soupape. — *Valve.*

B Entrée de la manche de gonflement. — *Entrance of inflation sleeve.*

CC' Regards. — *Inspection windows*

D Buse du Ballonnet. — *Scoop of ballonet.*

D' Buse du bourrelet inférieur. — *Scoop of lower fin.*

E Manche de communication. — *Communication Sleeve.*

F Manche de dégonflement — *Deflation sleeve.*

xx' / **yy''** Câble métallique de la suspension de traction — *Metallic suspension guys for cable suspension.*

l m n Cordes de manœuvre. — *Handling guys.*

K Panneau de déchirure. — *Ripping panel.*

——— Suspension de traction. — *Cable suspension*

—…… Suspentes de nacelle (avant et arrière). — *Forward and rear basket, suspension guys.*

—·—·— Suspentes de nacelle milieu. — *Middle basket guys.*

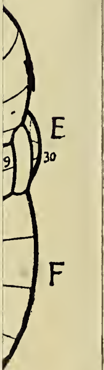


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Figure 2

Corderie du Gouvernail

Rudder rigging

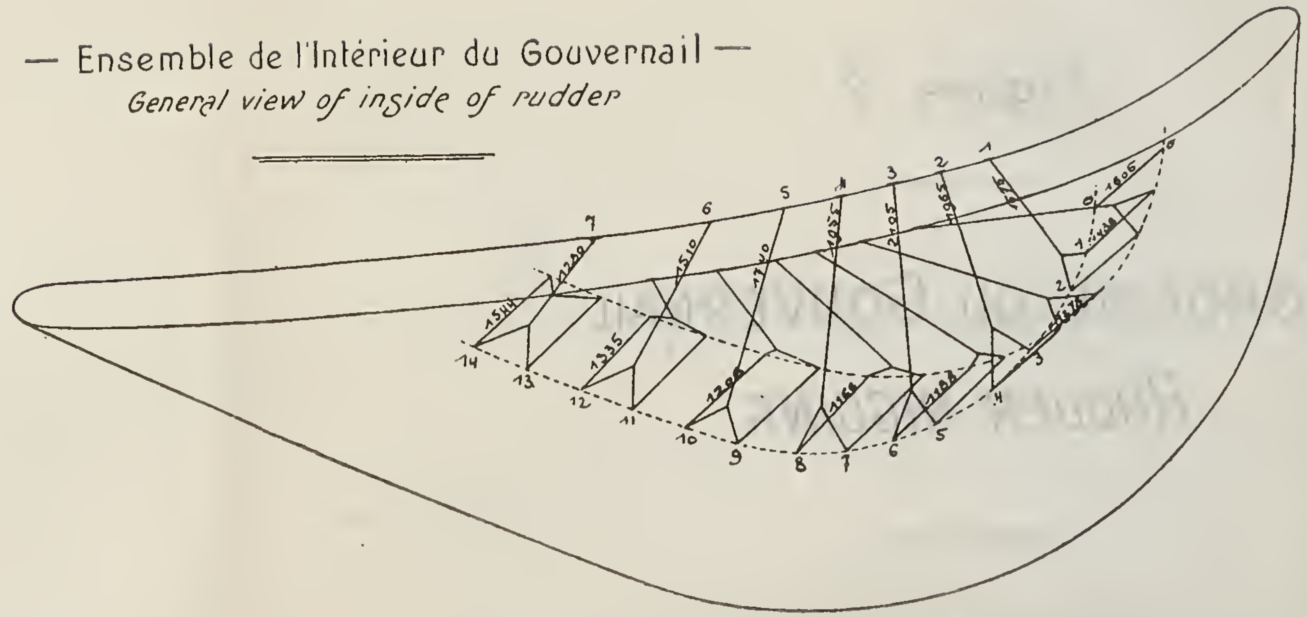
1 B

CORDERIE DU GOUVERNAIL

RUDDER RIGGING

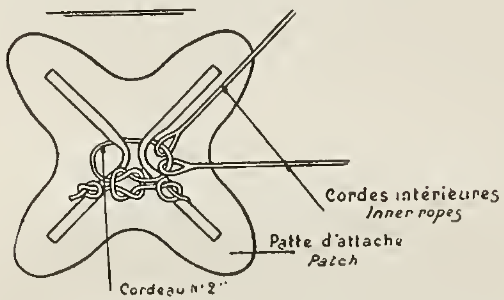
— Ensemble de l'Intérieur du Gouvernail —

General view of inside of rudder



Fixation des cordes intérieures aux pattes d'attache

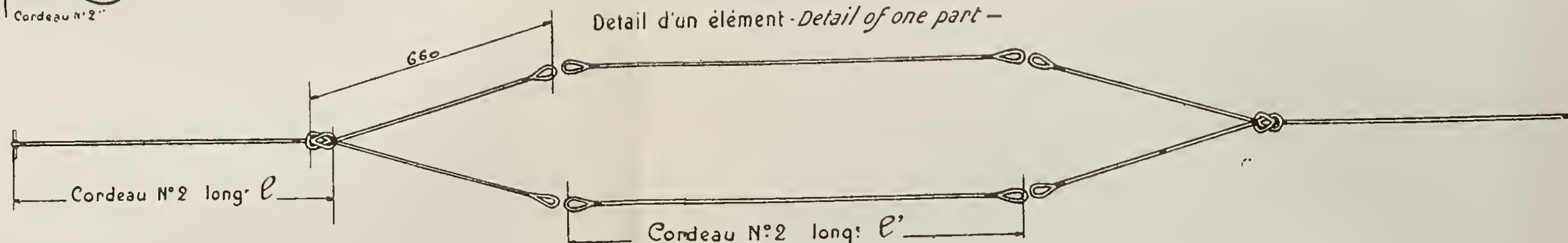
Fixing of inner ropes to patches



Cordes intérieures

— *Inner ropes* —

Detail d'un élément - *Detail of one part* —



Régime (*Set of bridles*)	3 éléments (*3 parts*) longueur (*length*) ℓ' (cordeau N°2)	longueur ℓ (*length* ℓ) (cordeau N°2)
N°0	1605	
N°1	1438	1675
N°2	1278	1965
N°3	1188	2105
N°4	1166	1955
N°5	1206	1740
N°6	1335	1510
N°7	1544	1280

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Figure 3

Commandes de Soupape

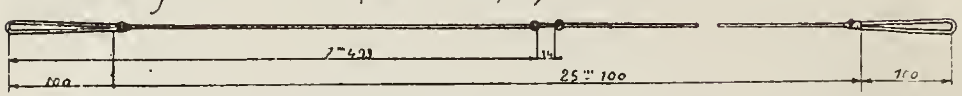
Valve Cords

1c

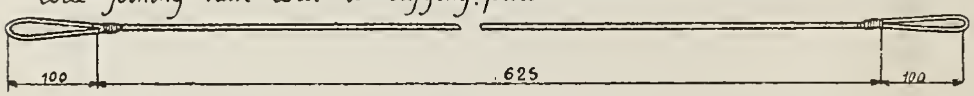
Commandes de Soupape

- Valve Cords -

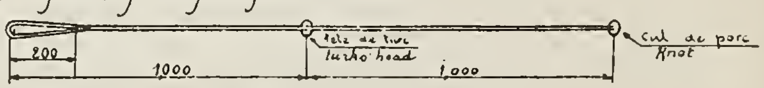
Cable d acier de 2⅞5 constituant la corde de soupape
Steel cable for valve cord (diameter 2 ⅞ 5)



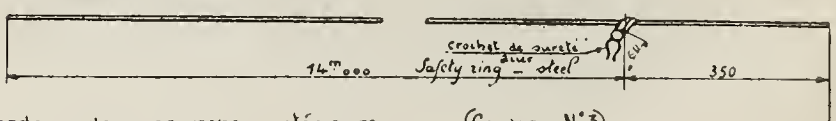
Cordeau N°3 réunissant la corde de soupape a la patte d' attache
Cord joining valve cord to rigging patch



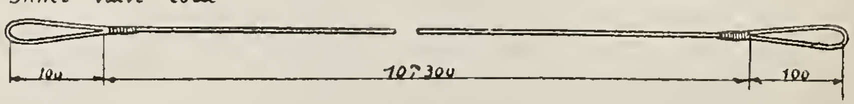
Cordeau N°3 permettant le reglage de la corde de soupape
Cord for regulating length of valve cord



Corde exterieure de soupape (Cordeau N°3)
Outer valve cord



Corde de soupape intérieure (Cordeau N°3)
Inner valve cord



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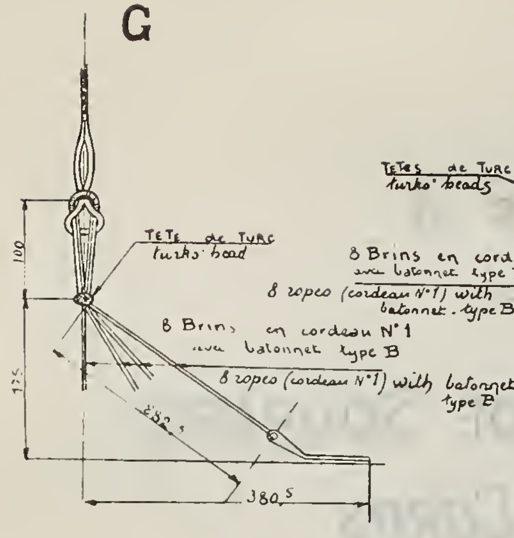
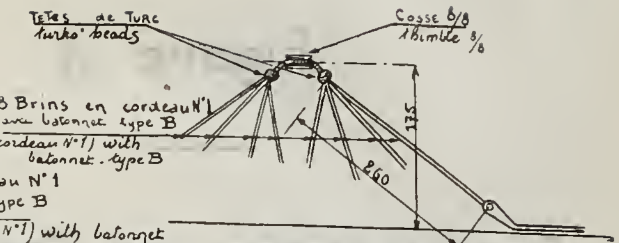
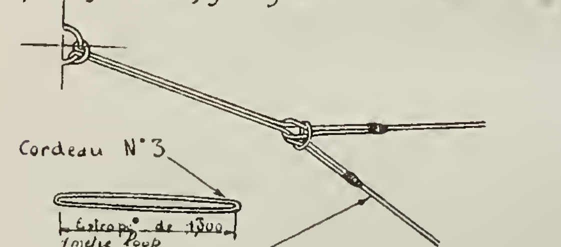


E



D

Estrope de 1000 et sa fixation a la soupape et au cable d acier
Loop (length 1 metre) joining valve plate to steel cord

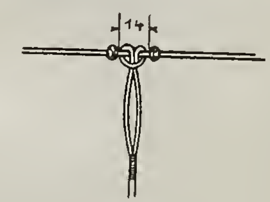


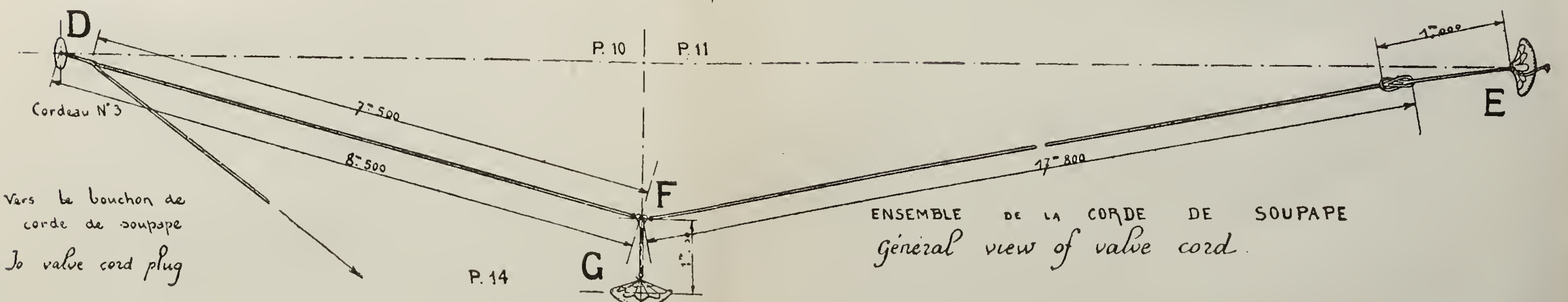
Attache sur l estrope de la corde de soupape exterieure
Outer valve cord attached to loop

F

Tetes de turc sur la corde de soupape , l' une a 8m 343 du point d' attache D

Turks heads on Valve cord - one placed at 8m343 of junction point D





Vers le bouchon de corde de soupape
To valve cord plug

ENSEMBLE DE LA CORDE DE SOUPAPE
Général view of valve cord

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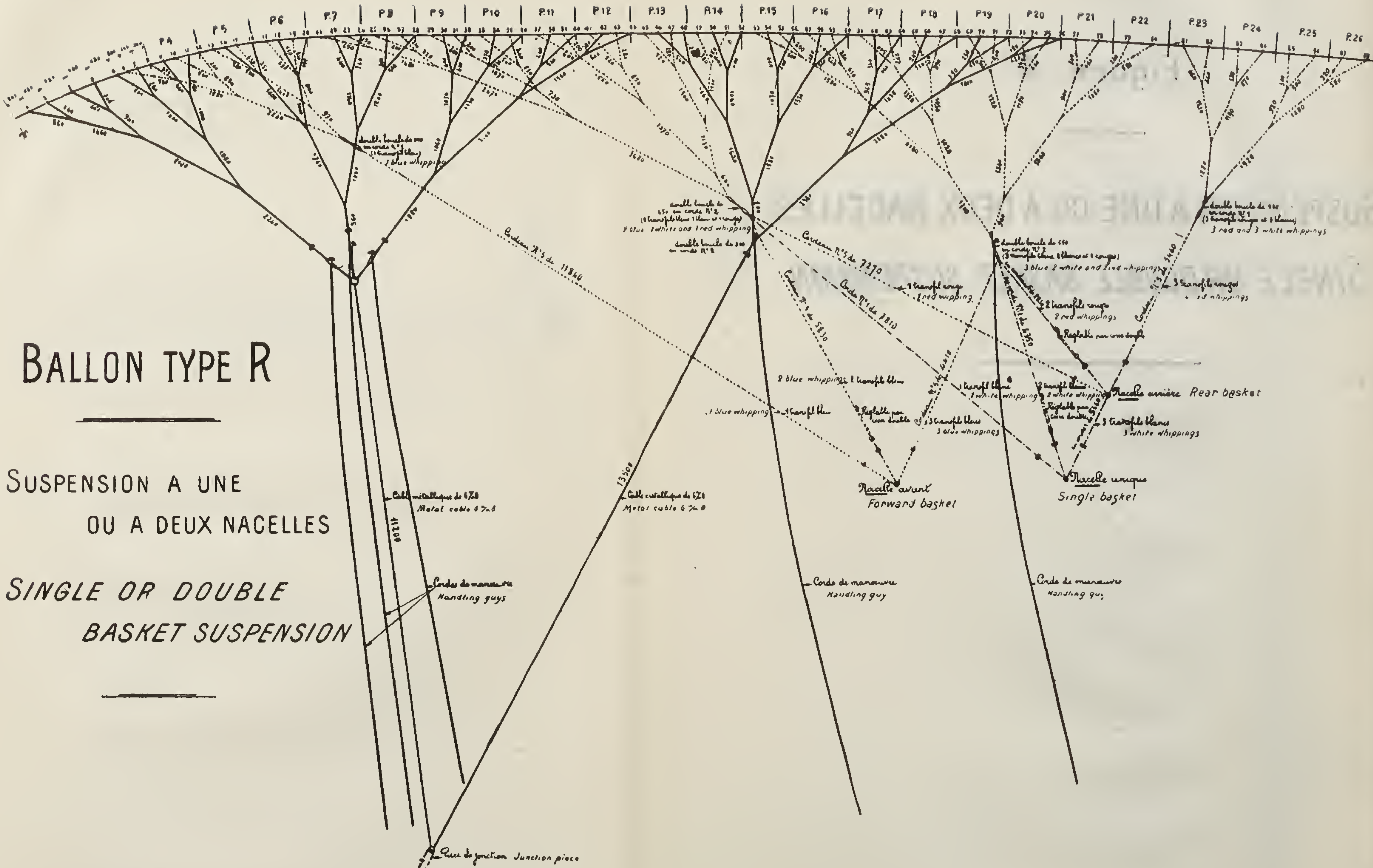
Figure 4

SUSPENSION A UNE OU A DEUX NACELLES

SINGLE OR DOUBLE BASKET. SUSPENSION

1 D



BALLON TYPE R

SUSPENSION A UNE
OU A DEUX NACELLES

SINGLE OR DOUBLE
BASKET SUSPENSION

2 D—71346—18

Figure 5

Suspension de Nacelle

Basket Suspension

1 E

SUSPENSION DE NACELLE _ *BASKET SUSPENSION*

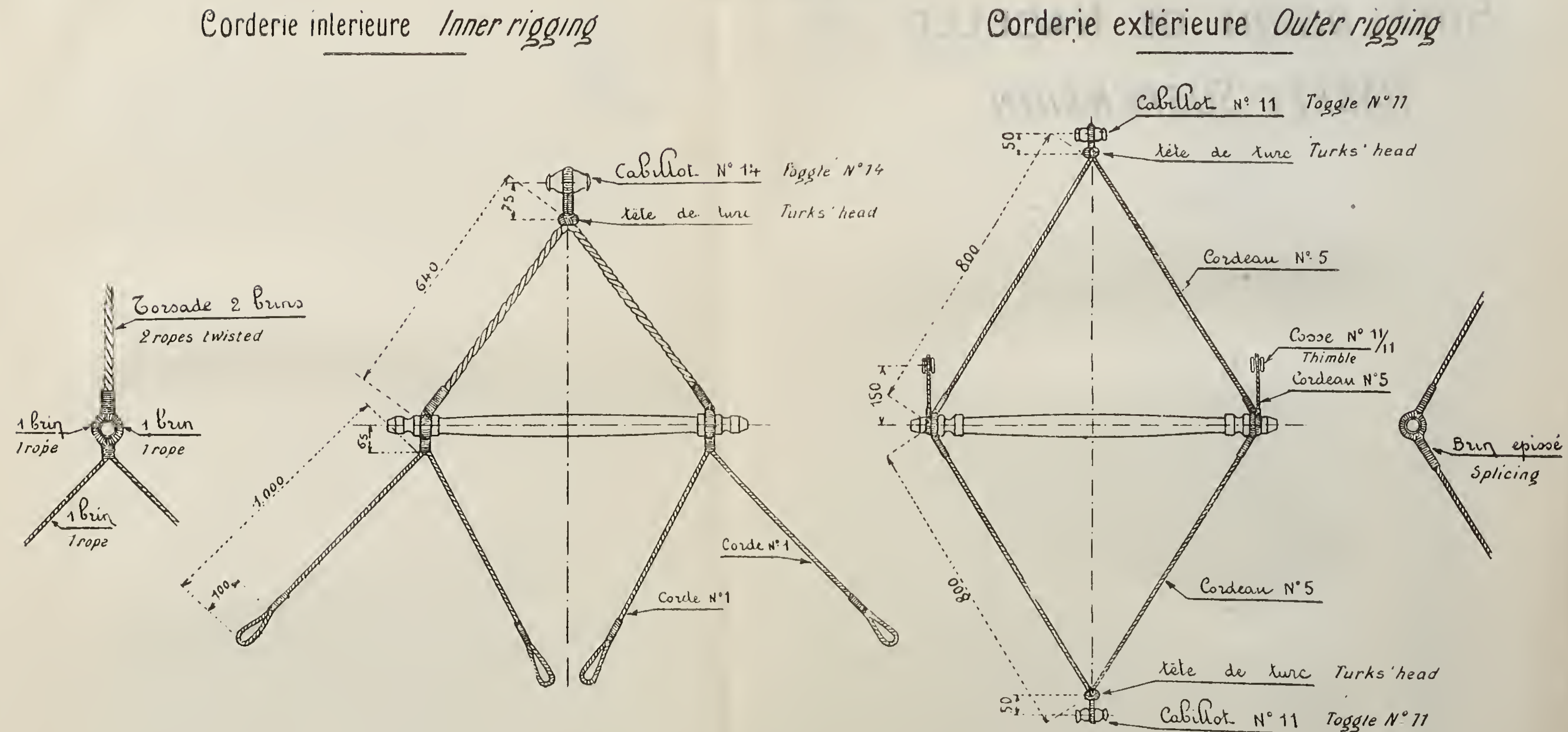


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Figure 6

SUSPENSION

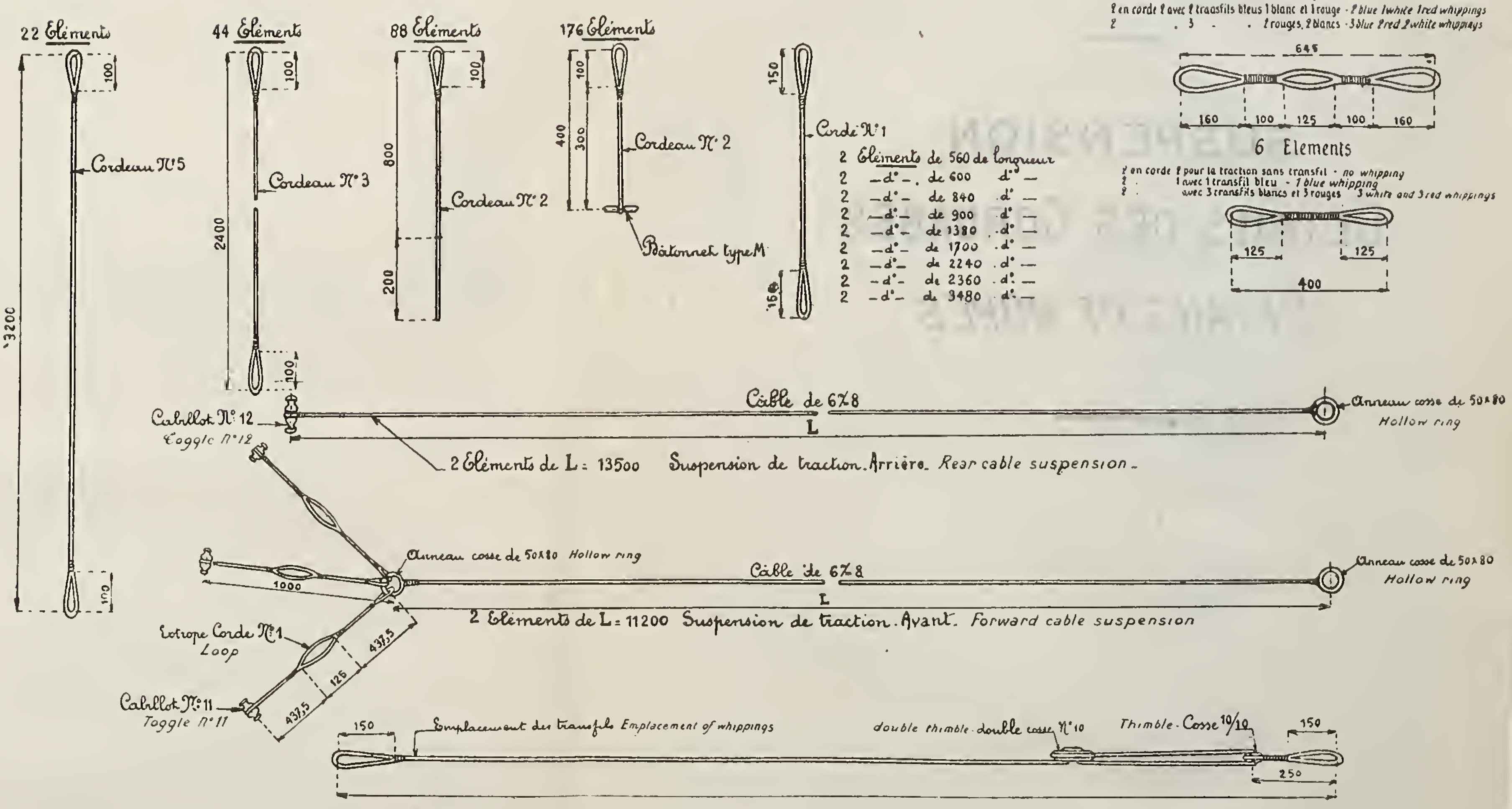
DETAILS DES CORDAGES

DETAILS OF ROPES

1 F

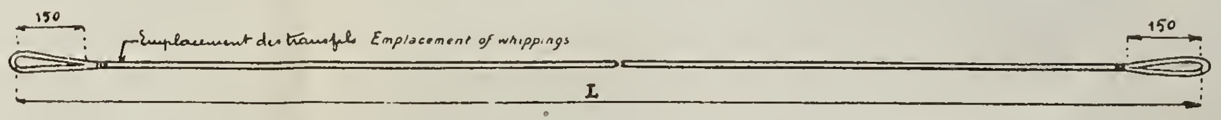
— SUSPENSION —

DETAILS DES CORDAGES - *DETAILS OF ROPES*



6 Elements Réglables -*(Adjustable)*

2 Eléments de 5830 en cordeau N° 5 Suspente milieu de la nacelle avant (2 transfils bleus) - *middle suspension guy forward basket (2 blue whippings)*
2 " 4350 en corde N° 1 Suspente milieu de la nacelle unique (2 transfils blancs) - *middle suspension guy single basket (2 white whippings)*
2 " 2850 en cordeau N° 5 Suspente milieu de la nacelle arriere (2 transfils rouges) - *middle suspension guy rear basket (2 red whippings)*

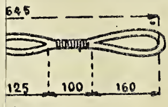


12 Elements

2 Elements de 11840 en cordeau N° 5 Suspente avant de la nacelle avant (1 transfil bleu) - *forward suspension guy forward basket (1 blue whipping)*
2 de 4410 en cordeau N° 5 Suspente arriere de la nacelle avant (3 transfils bleus) *rear suspension guy forward basket (3 blue whippings)*
2 de 7810 en corde N° 1 Suspente avant de la nacelle unique (1 transfil blanc) - *forward suspension guy single basket (1 white whipping)*
2 de 5660 en corde N° 1 Suspente arriere de la nacelle unique (3 transfils blancs) *rear suspension guy single basket (3 white whippings)*
2 de 7270 en cordeau N° 5 Suspente avant de la nacelle arriere (1 transfil rouge) *forward suspension guy rear basket (1 red whipping)*
2 de 3460 en cordeau N° 5 Suspente arriere de la nacelle arriere (3 transfils rouges) *rear suspension guy rear basket (3 red whippings)*

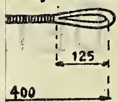
ments

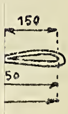
et 1 rouge - *2 blue 1white 1red whippings*
s, 2 blancs - *3 blue, 2red 2white whippings*



lements

ransfil - *no whipping*
1 blue whipping
t 3 rouges - *3 white and 3 red whippings*





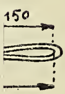
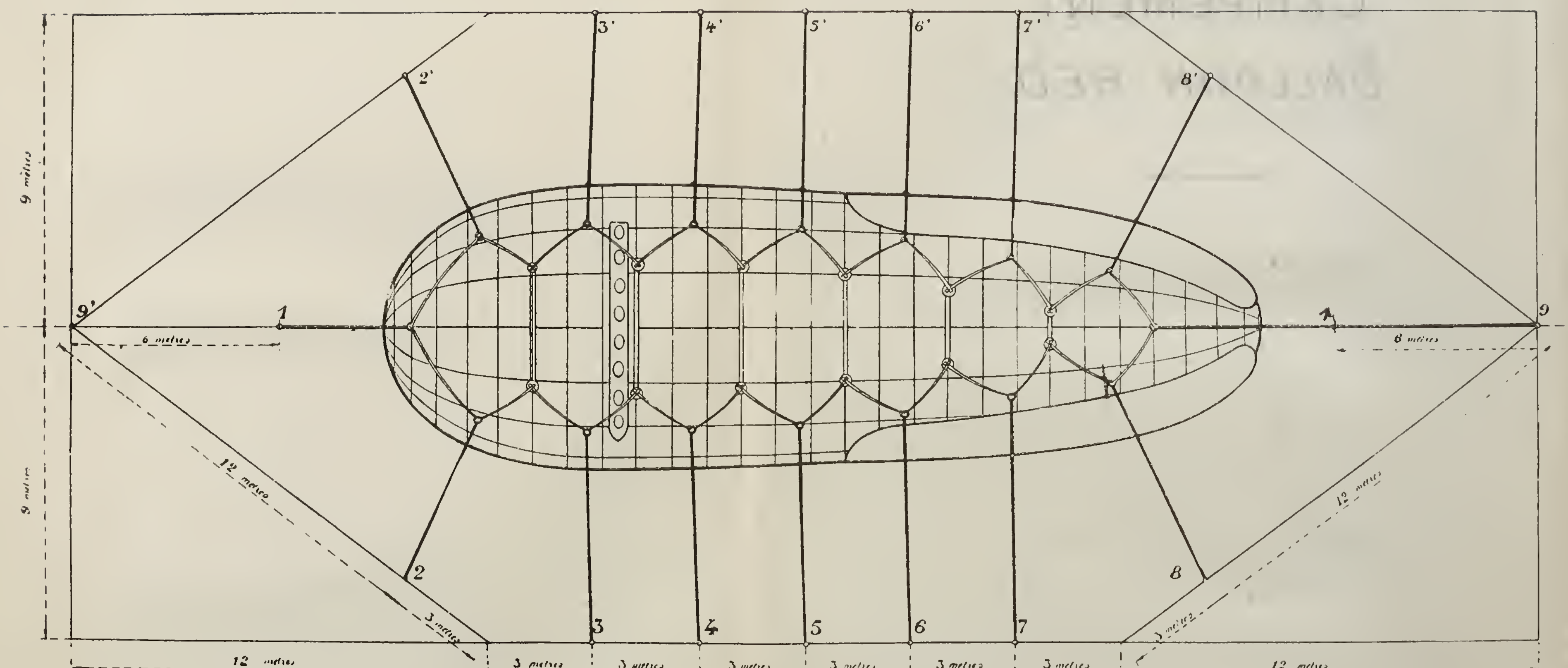


Figure 7

CAMPEMENT
BALLOON BED

1 G

Campement _ *Balloon bed*



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D. G. Cathcart, 2nd Lieut., A. S. (A.), Adjutant